TRAINS ANNUAL 1948

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1948

Edited by

Cecil J. Allen,

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THE "SOUTH COAST LIMITED" AT MOUNT LOFTY, SOUTH AUSTRALIAN GOVERNMENT RAILWAYS

[G. J. Jefferson

A NEW ALL-PULLMAN EXPRESS TRAIN IN 1947—THE SUMMER "DEVON BELLE" OF THE SOUTHERN RAILWAY
The "Belle," headed by "Merchant Navy" 4-6-2 No. 21C18, *British India Line*, is seen just beyond Basingstoke on its westbound journey. Engines were changed at Wilton, near Salisbury

Foreword

TRIALS of a new locomotive extended over a year are usually sufficient to enable a firm decision to be reached as to whether further engines of the same type should be built. At this time last year our first " mixed traffic " unit of this particular class left the running shed for an extended test ; and the result, notwithstanding a late start due to publishing delays, was successful even beyond our anticipation. We have therefore felt justified in turning out " No. 2 " of the series—*Trains Annual* 1948.

Again we have endeavoured to cover as much ground as possible in a limited space. The nearness of nationalisation, with the gradual submergence of all existing railway individuality that it must entail in the course of time, has prompted the inclusion of various reviews of a reminiscent type, concerning locomotives, locomotive driving, and traffic handling, and covering a wide area of the British railway world. For the same reason we have followed our previous policy of encouraging interest in railways overseas, including especially the United States, with its very high speeds and ultra-modern traffic control methods, and the up-to-date railways of Australia.

Among specialised chapters which, we are certain, will attract interest is one in which a railway artist of considerable competence has remodelled the externals of two familiar British Pacific locomotive types—in our judgment considerably to their advantage—and gives the reasons, both artistic and technical, for the changes he has made. In a second chapter deserving of mention, a well-known " top link " driver renowned for his speed leanings gives some impressions of his driving career. New ground is broken by an article on railway stamps, of particular interest to philatelists.

As with last year's volume, *Trains Annual* 1948 will commend itself, we feel sure, by the excellence of its illustration. For his work in the selection and arrangement of the photographs, special acknowledgement is due to Mr. G. Freeman Allen. As a year ago, we are encouraged to hope that the reception of *Trains Annual* 1948 will justify the addition annually of a new unit to the series which has made so auspicious a start.

THE EDITOR.

THE "MERCHANT NAVY" PACIFICS, SOUTHERN RAILWAY

By Howard W. A. Linecar

THE advent of the " Merchant Navy " Pacifics in 1941 promoted a stir in railway circles similar to that occasioned by the introduction of Sir Nigel Gresley's Pacifics on the Great Northern, when the foundations of the " big engine " policy in Great Britain were well and truly laid. With the ever-increasing strides in the development of electric, diesel-electric and turbo-electric locomotives it may yet be said of the " Merchant Navy " class that they were the last really new big engines built for British rails and that they marked the high water-mark in the development of large express locomotive power in this country.

Appearing during the dark days of the war, the " Merchant Navy " engines came as something of a tonic to the public at large ; in spite of all, it seemed, British railways were still going ahead. One cannot but admire the tenacity of purpose of their designer who, overcoming the many difficulties of the times, chose this moment to produce his new design.

That these locomotives contain a number of features which are revolutionary in railway practice in this country is a well-known fact, but how these new developments have functioned in practice, after six years of work in trying conditions, is of the greatest interest. The relative facts were disclosed very frankly by the designer of the engines, Mr. O. V. S. Bulleid, in a paper presented recently to the Institution of Mechanical Engineers.

As might be expected with locomotives embodying so many novel features, " teething troubles " with the new Pacifics were numerous, and much experimenting was needed before some of these were overcome. One, in spite of the " air-smoothing," was the drifting down of smoke and steam from the chimney, which obscured the driver's vision, and was caused by the passage of the locomotive through the atmosphere setting up regions of low pressure into which the exhaust was drawn. In an effort to cure this trouble a series of tests were carried out in the wind tunnel at the Southampton University, with a model, eight feet in length. As a result of these tests, which were followed by further tests in service, the present front end air-flow arrangements, including the canopy across the smokebox front, were adopted, with the result that the trouble was cured.

Difficulties were experienced also with the steam-pipes in the smokebox, which proved too rigid in the early engines of the class and were liable to crack and break, due to expansion stresses. This was overcome by the novel method of fitting corrugated steam pipes, which proved to be surprisingly flexible, and ensure steamtight joints over long periods of working.

Another steam-pipe trouble concerned the steam-pipes feeding the middle cylinder. These consisted of a 6-inch pipe branching from the 7-inch pipe which feeds the left-hand outside cylinder, and a 6-inch pipe branching from the 7-inch pipe feeding the right-hand outside cylinder. These two 6-inch pipes supplied the front and rear steam-chests respectively of the middle cylinder, and it was expected that the steam pressure in the two pipes and chests would equalise itself. Such proved not to be the case, with the result that the driven arm of the piston-valve rocker shaft of the middle cylinder broke. This was overcome by fitting two balancing pipes, of 12.6 square inches cross-section, which were cast in the cylinder block connecting the two steam-chests referred to, with the result that such breakages ceased.

One of the most novel features of these engines is the enclosure in an oil-bath of the three sets of valve-gear, the middle connecting-rod, the crosshead, slide-bar and crank-pin, to ensure better lubrication arrangements. This smacks somewhat of internal-combustion engine practice ; as a result, the number of points to be oiled by feeder was reduced from 92 to 31. In the base of the lubrication chamber there is a 40-gallon oil sump, from which oil is passed at a pressure of 20 pounds per square inch to delivery points in various parts of the valves and motion, reducing the hand-feeder lubrication by two-thirds, as has just been mentioned.

As a result of this method of lubrication, two cases only of overheated big-ends have occurred in nearly 1½ million miles of running, a fact of the more importance in that overheated big-ends may later result in the breaking of the crank-axle, which is costly both to make and to replace, not to mention the risks that may be entailed by such a fracture at speed. Another point is that the whole of the moving parts enclosed are completely protected from dirt and grit, a most commendable development.

The chain-driven valve-gear also caused much comment on its introduction. Many readers will remember the days of the chain-driven lorry and racing car, of how such chains stretched, and of the dreadful death of Parry Thomas, who was decapitated by the breakage of a similar chain while he was attacking records in a chain-driven racing car on Pendine Sands. Such possibilities were not overlooked by Mr. Bulleid, who fitted a chain 2 inches wide, capable of transmitting 75 h.p. at a chain speed of 130 feet per minute. In addition to an ample margin of strength over the maximum possible load that it could be called on to transmit, this specially designed chain was designed to stand up to the effects of snatch.

It was realised also that in time the chain might stretch, possibly as much as 3 inches, and it was therefore designed in such a way that the sag would mainly be taken up under load. Any sag that remained might affect the timing of the valves, but this slight amount could be offset easily by variation of the cut-off. Up to the time when Mr. Bulleid read his paper all had gone well ; no chain had broken and no appreciable sag had developed even after running up to 100,000 miles. The designer pointed out that the chain drive effects a saving in unsprung weight of just over half a ton (1,126 pounds), and that while a suitable Walschaerts valve-gear would weigh 1,150 pounds, the Bulleid gear weighs 945 pounds only.

The use of steel fireboxes, and still more that of welded construction, is noteworthy. It has long been held in this country that steel fireboxes were not to be compared with our more normal copper firebox, though the former type is common enough in America. The welded steel fireboxes fitted to the " Merchant Navy " engines have proved in prac-

tice to be most satisfactory, as also have the thermic syphons, which assist the flow of water in the boiler. Had it not been for the fact that these locomotives were built in war conditions, an all-welded boiler would have been fitted and the amount of welding used in the general construction would have been much greater.

The unusual type of driving wheels, which are so conspicuous a feature of the locomotives, received some comment in Mr. Bulleid's paper. During the last hundred years the method of using cast steel spoked wheels, on which are shrunk rolled steel tyres, has undergone little change ; but investigations have shown that in such wheels flexing occurs between spokes. Also it has been found that the stresses set up in the rim when the tyre is shrunk on vary greatly from spoke to spoke, so that the wheel itself is working under conditions of unequal strain.

The " B.F.B." type cast steel wheels used in the Southern Pacifics not only are 10 per cent lighter than spoked wheels of similar size, but are very strong laterally as well ; and it has been found that the stresses on the rim inside the tyre have been equalised. At the same time a new method has been developed of heating the tyre to expand it before shrinking it in position on the wheel. By this new method, which passes the tyre through gas-heated shoes, keeping the tyre continually on the move during the expanding period, equal heating of the tyre at all points has been achieved, resulting in equal expansion and shrinkage when the tyre cools on the wheel.

The opening and closing of the firebox door by a steam cylinder seems to have proved popular with the enginemen. This self-opening and self-closing door, which the fireman operates between each shovelful of coal by treading on a small pedal on the cab floor, also ensures that the firebox door is not left open for considerable periods during firing. Continuously open fire-doors admit a stream of cold air into the firebox, increasing wear-and-tear due to excessive expansions and contraction, and harmful in particular to the maintenance of such fittings as thermic syphons. Proper combustion of the fuel also is disturbed. The correct amount of air is passed into the firebox through a number of small holes, so arranged that the incoming air is preheated before entering the firebox.

It was pointed out during the discussion following the paper that the grate area of $48\frac{1}{2}$ square feet was almost that laid down in America as the maximum size capable of being fired normally by a single fireman. The American limit is 50 square feet, and several British Pacifics, such as those of the L.M.S.R., have 50 square feet of firegrate. Mr. Bulleid's reply on this point hinted that mechanical stoking is on its way in this country. Certainly it would seem that this assistance will be needed if firebox sizes have to be further increased to counteract the present declining quality of locomotive coal.

Finally the fact that the reciprocating parts of the Southern " Merchant Navy " locomotives are not balanced has not given any difficulty or caused undue track wear ; the absence of such balancing also has made possible a saving in weight of 432 pounds, which in the case of moving parts is a valuable economy.

The layout of the controls in the cab, which are so arranged that the driver and fireman do not get in each other's way while operating the engine, has proved popular, as also the arrangements for protection against draught. The only matter for criticism in the cab arrangements has been the restricted look-out ahead, especially on the driver's side, where the location of the brake-valve in front of the driver's window cuts off part of his already limited view. Like the view ahead, the restricted view astern caused some difficulty in tender-first running, until a look-out channel was provided between the

outer and inner sides of the upper part of the tender, with the cab end protected by a hinged glass screen. This channel provides a useful depository for the fire-irons.

With all allowance for the splendid quality of the work done in the past by the " King Arthur" and "Lord Nelson" 4-6-0's, the "Merchant Navy" Pacifics have revolutionised the train working over some sections of the Western Division, west of Salisbury in particular. Over the steep gradients of this route, notably the formidable climb to Honiton tunnel, they handle 17 bogie vehicles with ease, and on test a train of even 20 bogies has been handled without exceptional difficulty. Some of the test runs have broken all previous records over both the West of England and the Bournemouth main lines.

For example, No. 21C13, *Blue Funnel*, coming east from Exeter with a ten-coach train of 345 tons, entered Honiton tunnel at the unprecedented speed of 62 m.p.h., after climbing $4\frac{1}{2}$ miles at between 1 in 100 and 1 in 90, and, before that, the long grind up to milepost $161\frac{1}{4}$, beyond Whimple, which was completed at 68 m.p.h. Again, up the continuous ascent of 13 miles from below Axminster to Hewish summit, the locomotive kept up an average speed of 73.4 m.p.h. As to maximum speeds, 96 m.p.h. was reached before Seaton Junction and 90 m.p.h. down Crewkerne bank. So the 48.9 miles from Exeter to Yeovil Junction, for which the timetable allowed 55 minutes, were completed in 44 minutes 14 seconds.

A second feat of note was that of No. 21C2, *Union Castle*, in working a 17-coach train of 517 tons tare from Waterloo down to Bournemouth in less than the pre-war 116-minute timing of the "Bournemouth Limited," on which the load limit used to be 365 tons. By Surbiton the Pacific's speed on level track was 75 m.p.h., and an average of 74.3 m.p.h. was maintained from there to Byfleet ; then came a bad track relaying check, costing over three minutes, and spoiling the climb to milepost 31. From Farnborough to Basingstoke speed averaged 71.5 m.p.h., and again reached 75 m.p.h. on the level. No very high speeds were run down past Winchester, but Northam Junction, 78.1 miles from Waterloo, was passed in 77 minutes 15 seconds, and, after the long and severe slowing through Southampton, Bournemouth Central, 107.9 miles, was reached in 112 minutes 46 seconds, or 109 minutes net.

On a third run, from Victoria to Dover, No. 21C3, *Royal Mail*, had to tackle a train of ten Pullmans and four bogies weighing in all 454 tons, and achieved some brilliant running. Notwithstanding the many slacks and extremely steep gradients in the London area, as far as Knockholt, the engine gained time steadily, and when the driver could at last open out, *Royal Mail* ran the 29.4 miles from Paddock Wood to Westenhanger, level or slightly rising, at 78.6 m.p.h., and reached all but 90 m.p.h. on level track—with driving wheels of no greater diameter than 6 ft. 2 in. From Staplehurst to Headcorn the mean speed was 86.7 m.p.h. With allowance for all the out-of-course signal and permanent way checks, *Royal Mail* had completed the 78.0 miles from Victoria to Dover Marine in a net time of not more than 78 minutes.

In normal running, No. 21C7, *Aberdeen Commonwealth*, with the heavy 14-car " Devon Belle " weighing 545 tons, has covered the 46.7 miles from Semley to Seaton Junction, pass-to-pass, in 39 minutes, 46 seconds, with speeds of 86 m.p.h. at Gillingham, 87 before Templecombe, 90 at Sherborne, and 82 at Axminster. Such performances as these leave no doubt as to the possibilities that the " Merchant Navy " Pacifics, and their equally capable " West Country " sisters, will put within the reach of the Southern Railway operating authorities when unlimited high speed once again becomes possible.

ONE HUNDRED MILES AN HOUR IN THE U.S.A.

By Cecil J. Allen, M.Inst.T., A.I.Loco.E.

FROM time to time references are made by railway writers to the fact that on certain main lines in the United States train speeds up to one hundred miles an hour are now becoming so common as no longer to excite particular comment. Some readers may have been inclined to receive this statement with a certain amount of scepticism—polite or otherwise—regarding the story as having been stretched to some extent in course of its transmission across the Atlantic. The present chapter may help them to think otherwise.

It is based on details which I have received from two much-travelled friends in the United States—Mr. Eric Crickmay and Mr. E. L. Thompson—both of whom make a practice, like students in this country of " British Locomotive Practice and Performance," of recording the running of the trains by which they travel. These logs make it clear, not only that maximum speeds of 100 m.p.h. are attained, but that the locomotives, both diesel and steam, keep up such speeds for considerable distances, and with quite substantial trains.

Readers will notice that, even on the fastest schedules, the engines and their crews seem to have an almost indefinite capacity for making up lost time. It should be said here that the American driver, in general, is expected to make up arrears of time, even though it may have been lost by circumstances quite outside his control. What is so noticeable in many of these runs is the determination that the engine-crews display to make good any late start at the earliest possible moment, so that their train, well behind time, perhaps, at one stage of the run, is back to schedule at the second or third subsequent stop, and from there onwards sticks closely to the timetable.

Most of the runs about to be described were made between Chicago and St. Paul. Between Chicago and the Twin Cities of St. Paul and Minneapolis there are three competing high speed services, all streamline trains—the morning and evening "Zephyrs" of the Chicago, Burlington and Quincy; the morning and evening "Hiawatha" trains of the Chicago, Milwaukee, St. Paul and Pacific ; and "The 400" of the Chicago and North Western Railway.

The distances from Chicago to St. Paul by the three routes are 427, 411, and 408½ miles, and the overall time, with about eight intermediate stops, is 6½ hours on some of the runs. Before the war this had got down to 6¼ hours—6 hours flat by the westbound Burlington " Morning Zephyr "—and the increase of 15 minutes was to compensate for heavier wartime loads. But most of the services have reverted recently to the 6¼-hour schedule.

First of all, then, a run on the eastbound "Morning Zephyr" of the Burlington route.

IN THE U.S.A. TO-DAY

Left :

MODERN DIESEL-ELECTRIC POWER
A quadruple-unit locomotive of 6,000 b.h.p., as used to haul the "Super-Chief" of the Santa Fe through for 2,227 miles from Chicago to Los Angeles

Below :

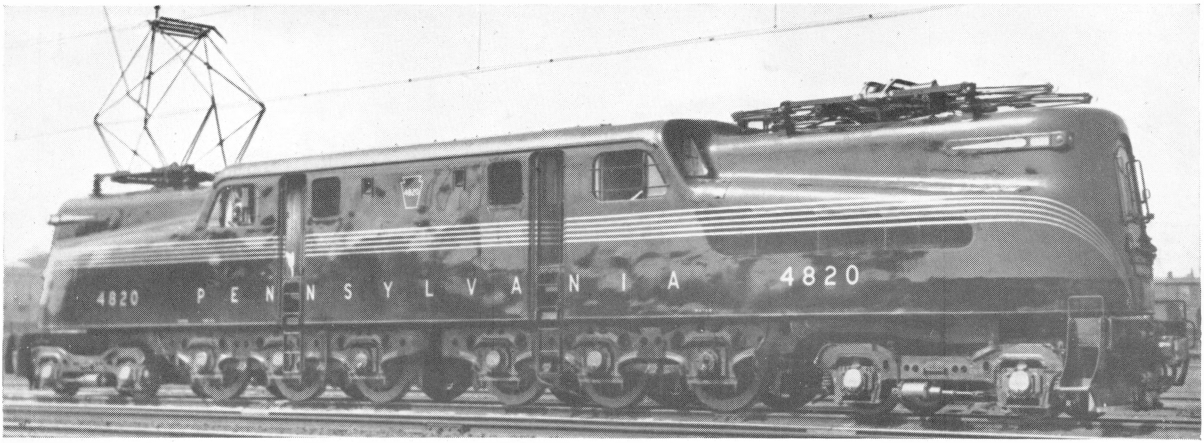
DRAWING OUT OF THE "WINDY CITY"—A twin-unit diesel of 4,000 b.h.p. heads the "Twin Cities 400" westwards from Chicago to St. Paul and Minneapolis

IN THE U.S.A. TO-DAY

ON THE PENNSYLVANIA ELECTRIC SPEEDWAY—A "GG-1" electric locomotive of the 2-C-C-2 type speeds the "President" from New York to Washington, D.C.

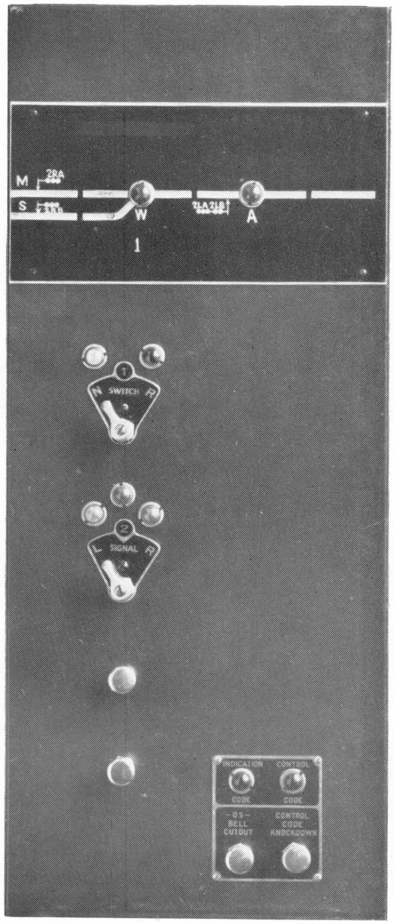
[Rail Photo Service, Boston, Mass.

AN AMERICAN STEAM MAMMOTH AT WORK—A 4-8-4 of the Santa Fe breasts Cajon Pass summit with the "Chief," en route from Chicago to Los Angeles. Engine and 16-wheel tender weigh 432 tons



Rail Photo Service, Boston, Mass]

ELECTRIC GRACE—One of the powerful " GG-1 " class electrics of the Pennsylvania Railroad, 2-C-C-2 type, as used between New York and Washington

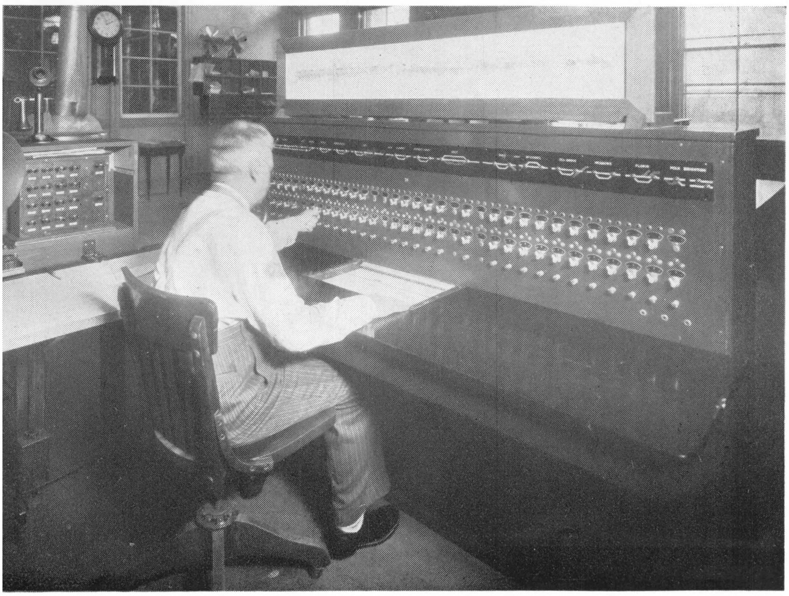


[*Courtesy : Westinghouse Brake and Signal Co., Ltd.*]

KEEPING U.S.A. TRAFFIC MOVING

(*see article on page 39*)

CENTRALISED TRAFFIC CONTROL—Below is seen the panel controlling about 50 miles of the San Joaquin Valley line of the Southern Pacific, U.S.A., between Brighton (Sacramento) and El Pinal. The illuminated track diagram is seen above the control panel. To the right is a section of the control panel showing operating thumb-switches for points and signals.



[*Courtesy : Union Switch and Signal Co.*]

THE BIGGEST REINFORCED CONCRETE RAILWAY BRIDGE SPAN IN THE WORLD
The Lorraine Bridge, Berne, carrying four tracks of the Berne-Zurich main line, Swiss Federal Railways, across the River Aar with a clear span of 150 metres (492 feet)

The train was made up to ten modern 85-ft. streamline cars (about 540 tons with passengers and luggage), and was hauled by a twin-unit diesel-electric locomotive, No. 9909. Waiting connections at St. Paul made the departure 12 minutes late, and negotiation of the tortuous St. Paul yard, with a signal check included, caused $9\frac{1}{2}$ minutes to be spent on the first half-mile. Past St. Croix signal tower the "Zephyr" was 20 minutes late. Then the fun began, though there was so much overtime at stations that on this trip the second driver did not win back to schedule till he was nearly into Chicago.

For 79.4 miles from Prescott to Winona Junction stop, speed averaged 83.6 m.p.h., and of this distance the 8.2 miles from Alma to Cochrane were run at 103.6 m.p.h. Fully 200 miles of the journey—all but one-half the total distance—were covered at a mean speed of 90 m.p.h., and some of the start-to-stop runs were amazingly fast, particularly from La Crosse to Prairie du Chien, 57.7 miles in $40\frac{3}{4}$ minutes (85.0 m.p.h. start to stop), and Prairie du Chien to East Dubuque, 54.6 miles in $40\frac{1}{4}$ minutes (81.4 m.p.h. start to stop). The British equivalent would be to come from Birmingham to Euston in about 82 or 83 minutes, with a one-minute stop at Bletchley included! From St. Paul yard to Chicago, 426.4 miles, including the locomotive's slowing down to and accelerating from eight intermediate stops, and all service speed restrictions, the running time of the "Zephyr" was 5 hours, $44\frac{1}{4}$ minutes; the drivers had regained no less than 31 minutes in all on one of the world's fastest schedules, and the flyer triumphantly came to a stand in Chicago $2\frac{3}{4}$ minutes early!

We turn now to the Milwaukee route. The runs on the "Hiawatha" are of special interest because they compare the work of the magnificent 4-6-4 steam locomotives of the Milwaukee with that of the diesels which, to the regret of all steam-lovers, have now displaced them. When the "Hiawatha" was first introduced, in 1935, special streamlined Atlantics were built to haul it; then, as the weight of the train increased, they were supplanted by the 1938 4-6-4's. The former were oil-fired, but the latter are coal-fired; the 4-6-4 engines have $23\frac{1}{2}$ in. by 30 in. cylinders, 7 ft. driving wheels, 300 lb. pressure, 5,861 sq. ft. combined heating surface, 96.5 sq. ft. of firegrate, 50,300 lb. tractive effort, and a weight of $185\frac{1}{4}$ tons, or 353 tons in running trim with 12-wheel tender included.

Like the "Zephyr," the "Hiawatha" was delayed on leaving St. Paul, so that 4-6-4 No. 100, with her 465-ton nine-coach train, was 10 minutes behind time from Red Wing, 40.6 miles after starting. It is not till after leaving La Crosse, on this route, that 100 m.p.h. speeds become permissible; from there onwards the log was sprinkled liberally with them the whole way to Chicago. Indeed, 148 individual miles of the route were covered at 90 m.p.h. and over, out of which 58 miles were at between 100 and 106 m.p.h.

The acceleration of the engine from each stop was amazing; such times from the dead start as 8 min. 16 sec. for the 9.0 miles from Portage to Wyocena, or 8 min. 20 sec. for the 9.1 miles from Columbus to Reeseville, find no counterpart in Great Britain, nor the succession of almost incredibly quick start-to-stop times over comparatively short distances, such as La Crosse to Sparta, 24.6 miles in 20 min. 3 sec., Sparta to Portage, 78.3 miles in 57 min. 14 sec., and Portage to Columbus, 28.2 miles in 22 min. 36 sec. Yet over these stages the 4-6-4 was doing no more than keep bare time!

The two most exciting stretches were from Sparta to Portage and from Milwaukee to Chicago. At that time the former 78.3 miles was booked to be covered in 58 minutes start to stop—a mile more than from Swindon to Paddington in 7 minutes less than the "Cheltenham Flyer", notwithstanding the fact that 10 miles after starting the train comes

A QUESTION OF LINE

By A. N. Wolstenholme

DURING and since the last war the necessity for general economy has brought about changes in the proud outlines of many British locomotive types. Streamline casings have been removed from the " Coronation " class Pacifics of the L.M.S.R. with quite considerable technical advantages, which include the greater accessibility of components and a reduction in smoke deflection troubles. Similarly the " A4 " Pacifics of the L.N.E.R. have been stripped of their lower fairings, or " valances," to simplify maintenance. Fully justifiable though these modifications may have been, in both cases they have resulted in locomotives that, to the writer in any event, look as though they are not quite sure of what they are intended to be. They seem to have lost their self-respect, and one can recall many unhappy moments in the presence of these grimy iron slaves, reflecting upon their former magnificence.

Why should the removal of a few panels have such an effect upon the character of a locomotive ? Why was it that Swindon, in removing the streamline fairings applied experimentally to *King Henry VII* and *Manorbier Castle*, actually enhanced the appearance of both engines ? These two contradictory questions can be answered broadly by the phrase " It's all a question of line." Whereas we had come to recognise Sir Nigel Gresley's " A4's " and Mr. Stanier's " Coronations " as completely streamlined types which were designed as such, the fairings fitted to the G.W.R. engines were only accepted as experimental additions to what already were beautifully proportioned machines. On the other hand, as a result of the " utility " policy, the Gresley greyhounds suddenly looked very wasp-waisted and cold about the knees, whilst on the L.M.S.R. the sight of a disrobed *Duchess* bustling along with cape-like smoke deflectors drawn tightly about her slant-topped smokebox could evoke nothing but sympathy.

Many surprises have been sprung upon the enthusiast in the new outlines of rebuilt locomotives. Some are pleasant indeed. Not only do they compare favourably with the original design, but sometimes they improve upon it. Unfortunately this has not been the result in all cases. For instance, with all allowance for the prejudice that we are bound to have in favour of the original design, many a sad head has been shaken in contemplation of a Thompson Pacific on the L.N.E.R. Why do I choose this type as a target for criticism ? Possibly because an artist finds it easy to appreciate the proportions of such a design as the original Gresley " A1 " or the " A3."

It is proportion that worries me when I look at an " A2," especially the new fellows with their flat-fronted cabs. Strangely enough, that cab looks all right on an " A3," but here it seems to hang precariously on to a lengthy boiler narrowed by high frames. Whilst the poor little dome, clinging shyly to the top line, the " Town Hall steps " for'ard and the vacant space beneath them, the vast smoke deflectors fitted to most of the engines and the flat-chested smokebox door—all combine to offend the eye. This criticism is no doubt severe when one considers the conditions in which the new type was built, and that in some ways at least it may be an improvement technically on its pre-

The train was made up to ten modern 85-ft. streamline cars (about 540 tons with passengers and luggage), and was hauled by a twin-unit diesel-electric locomotive, No. 9909. Waiting connections at St. Paul made the departure 12 minutes late, and negotiation of the tortuous St. Paul yard, with a signal check included, caused 9½ minutes to be spent on the first half-mile. Past St. Croix signal tower the "Zephyr" was 20 minutes late. Then the fun began, though there was so much overtime at stations that on this trip the second driver did not win back to schedule till he was nearly into Chicago.

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Like the " Zephyr," the " Hiawatha " was delayed on leaving St. Paul, so that 4-6-4 No. 100, with her 465-ton nine-coach train, was 10 minutes behind time from Red Wing, 40.6 miles after starting. It is not till after leaving La Crosse, on this route, that 100 m.p.h. speeds become permissible ; from there onwards the log was sprinkled liberally with them the whole way to Chicago. Indeed, 148 individual miles of the route were covered at 90 m.p.h. and over, out of which 58 miles were at between 100 and 106 m.p.h.

The acceleration of the engine from each stop was amazing ; such times from the dead start as 8 min. 16 sec. for the 9.0 miles from Portage to Wyocena, or 8 min. 20 sec. for the 9.1 miles from Columbus to Reeseville, find no counterpart in Great Britain, nor the succession of almost incredibly quick start-to-stop times over comparatively short distances, such as La Crosse to Sparta, 24.6 miles in 20 min. 3 sec., Sparta to Portage, 78.3 miles in 57 min. 14 sec., and Portage to Columbus, 28.2 miles in 22 min. 36 sec. Yet over these stages the 4-6-4 was doing no more than keep bare time !

The two most exciting stretches were from Sparta to Portage and from Milwaukee to Chicago. At that time the former 78.3 miles was booked to be covered in 58 minutes start to stop—a mile more than from Swindon to Paddington in 7 minutes less than the "Cheltenham Flyer", notwithstanding the fact that 10 miles after starting the train comes

to a 3-mile section of single track, at both ends of which 40 m.p.h. slacks are called for. Moreover, these slacks come in the middle of a 10-mile bank which for most of its length is at 1 in 200 up, and finishes at 1 in 150. On the 1 in 200 up (like the L.N.E.R. 1 in 200 from Wood Green to Potters Bar), the engine reached a steady 80-82 m.p.h., passing Tunnel City, 13.0 miles and the end of the single line, in 12 min. 2 sec.

Then, as an American commentator might say, " the hogger threw away the bridle." About 19 miles from the Sparta start speed crossed the three-figure line ; 11 miles were now run at an average of 102.3 m.p.h., and after a slack to 50 m.p.h. through Camp Douglas, there were two more long stretches in the 100's—14 miles at 100.4 m.p.h. before easing through Wisconsin Dells, and 9 miles at 100.6 before the Portage stop. The 78.3 miles had been covered in 57 min. 14 sec., start to stop, and with all this terrific effort the engine had gained no more than $\frac{3}{4}$-minute on schedule !

The same thing happened once again after leaving Milwaukee, save that this well-known racing stretch has no hindrances to speed, other than the very slow running needed through the environs of both Milwaukee and Chicago. So the first 7.1 miles out of Chicago to Lake took 10 min. 56 sec., but after that the 4-6-4 simply streaked for home. From Lake to Tower A20, 57.6 miles, the working book allows 40 minutes, and one would hardly imagine that a timing of 86.4 m.p.h. left much margin. Yet here the flyer gained precisely *four minutes* ! For 62 miles right off the speed was unvaryingly between 90 and 106 m.p.h.; this distance was covered in 37 min. 50 sec., at an average of 98.3 m.p.h., and 27 individual miles were run at speeds of 100 to 106 m.p.h.

It should be added that the prescribed speed limit is 100 m.p.h., with a " tolerance " to 105 m.p.h.; but for this, even higher speeds might have been attained. Moreover, it should not escape notice that the engine had been blazing away for five hours continuously before this amazing final sprint was made. Eventually, after a very easy finish, the driver of No. 100 pulled up in Chicago $\frac{3}{4}$-minute early. The two drivers had expended a time, allowing for one signal check, of $347\frac{1}{2}$ minutes on the $410\frac{1}{2}$-mile journey—so gaining $11\frac{1}{2}$ minutes on schedule—including slowing down and restarting from seven intermediate stops, and time lost by numerous service slacks. Such is the capacity of modern American steam locomotive power.

Unfortunately the comparison diesel runs were made after the wartime slowing of 15 minutes had become operative, and so probably do not show the maximum of which these powerful locomotives are capable. Where late starts were made, they were recovered in a very short distance, and booked times were then closely adhered to. For example, with a 520-ton train of 10 cars, twin-unit diesel No. 14 left Red Wing 12 minutes late, regained 5 minutes to Winona (62.4 miles in 51 min. 58 sec.), and another $6\frac{1}{4}$ minutes from there to La Crosse (26.7 miles in 25 min. 42 sec., including a crawl over the swingbridge outside La Crosse). From La Crosse the train was on time.

Of the increased time allowance, 4 minutes has been added to the terribly tight Sparta-Portage allowance, so that this booking, though still 78.3 miles in 62 minutes, is not quite so hectic as before. Notwithstanding this, the diesels can hare along quite comfortably at 100 m.p.h.; on this run, with 520 tons, diesel No. 14 covered 19 miles of the Milwaukee-Chicago section at 100.6 m.p.h.; and diesel No. 15, with a heavier load of 575 tons, did 20.2 miles at 101.0 m.p.h. The net running time of the former throughout from St. Paul to Chicago, $410\frac{1}{2}$ miles, was 351 minutes, and of the latter 349 minutes ; the timetable allows 372 minutes.

What the diesels are capable of is shown better, perhaps, by a "Hiawatha" run in the reverse direction, when the load had crept up to 14 cars, with a total weight of about 730 tons, including passengers and luggage. This would equal at least 22 coaches of L.M.S.R. standard corridor stock. Yet the 100 m.p.h. maximum was reached just the same ; 63.6 miles from Morton Grove to Lake were covered in 42¼ minutes, at 90.3 m.p.h. (including 5.1 miles at 102.0 m.p.h.), and there was another " 100 " later in the journey, where 19.6 miles (Camp McCoy to West Salem) were reeled off at 98.0 m.p.h. Some of the start to stop runs were very fast—Chicago to Milwaukee, 85.0 miles in 69 minutes ; Milwaukee to Portage, 92.9 miles in 80¼ minutes ; and New Lisbon to La Crosse, 59.8 miles in 47¼ minutes. Running times for the complete 411½ miles from Chicago to St. Paul add up to precisely six hours net—a gain of 15 minutes on schedule.

Finally, as an illustration of what the Americans can do with straight electric power, there are some runs on the electrified main line of the Pennsylvania Railroad from New York to Washington, one of the busiest—between New York and Philadelphia, probably *the* busiest—main lines in the world. Here just the same determination to recover lost time is apparent. One Saturday, for example, the "President" from New York to Washington, was delayed by signals to such an extent as to leave Trenton, 58.1 miles from the start, 18 minutes late. The locomotive was one of the big streamlined 2-C-C-2 type (4-6-6-4) of Class " GG1," and the train an assemblage of 15 heavy standard cars, of probably 1,150 tons weight at least.

What happened ? Accelerating like lightning with this enormous load, No. 4808 was through Greene, 8.5 miles, in 8 minutes, and ran the 27.9 miles to North Philadelphia in 22½ minutes. After stopping here and at 30th Street, the 25.7 miles from the latter to Wilmington were covered in 22 minutes ; the 64.8 miles from Wilmington to passing Bay View, with a long slack over the Havre de Grace viaduct, were run in 50¼ minutes, and notwithstanding the usual slow approach to Baltimore, the 68.4 miles from Wilmington to Baltimore were run in 57¼ minutes. The final stage of 40.1 miles from Baltimore to Washington took 36¼ minutes. At stops 5 minutes overtime had been spent, but the arrival in Washington was not more than 1½ minutes late. One stretch of 15.2 miles was covered at 93.5 m.p.h., and no less than 128 miles at an average of 81.0 m.p.h.

In the reverse direction the "Congressional", from Washington to New York, is now so heavily patronised that an "Advance Congressional" has to be run daily, and is booked without a stop over the 214.6 miles from Washington to Newark, outside New York—easily the longest non-stop run in the world with straight electric power. The time allowed is 195 minutes, including very slow running, down to 15 m.p.h., through Baltimore, and 40 m.p.h. through the great city of Philadelphia, as well as various other service slacks. Yet time is improved on easily.

On one run, with 14 cars (about 1,050 tons), a total of 166 miles was run off at 79.7 m.p.h. average, with long stretches at round about the 90 m.p.h. mark. Newark was reached 7½ minutes early. On another trip, with the same load, the locomotive passed Princeton Junction, 176.2 miles from the start, in 157¾ minutes, and could have been right through to Newark with ease in three hours flat—71.5 m.p.h. start to stop—had it not been for concluding signal checks. This kind of thing is typical of what is going on over many American main lines to-day. They have left well behind all our own pre-war notions of speed on rails, and it is evident that in this matter we in Great Britain, even apart from the effects of war, have nothing whatever to teach them.

A QUESTION OF LINE

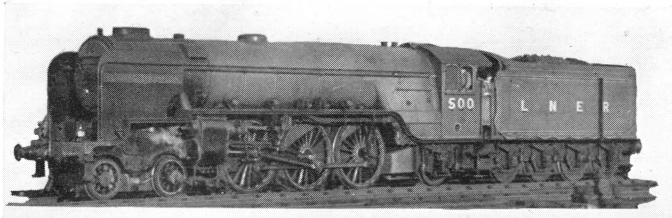
By A. N. Wolstenholme

DURING and since the last war the necessity for general economy has brought about changes in the proud outlines of many British locomotive types. Streamline casings have been removed from the " Coronation " class Pacifics of the L.M.S.R. with quite considerable technical advantages, which include the greater accessibility of components and a reduction in smoke deflection troubles. Similarly the " A4 " Pacifics of the L.N.E.R. have been stripped of their lower fairings, or " valances," to simplify maintenance. Fully justifiable though these modifications may have been, in both cases they have resulted in locomotives that, to the writer in any event, look as though they are not quite sure of what they are intended to be. They seem to have lost their self-respect, and one can recall many unhappy moments in the presence of these grimy iron slaves, reflecting upon their former magnificence.

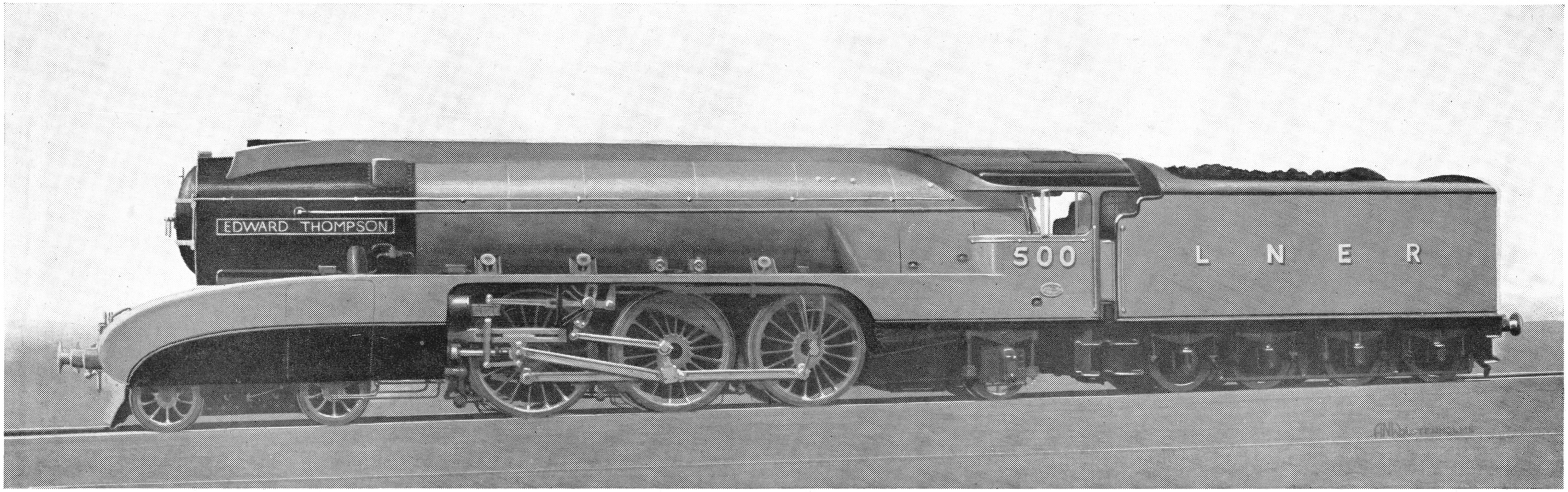
Why should the removal of a few panels have such an effect upon the character of a locomotive ? Why was it that Swindon, in removing the streamline fairings applied experimentally to *King Henry VII* and *Manorbier Castle*, actually enhanced the appearance of both engines ? These two contradictory questions can be answered broadly by the phrase " It's all a question of line." Whereas we had come to recognise Sir Nigel Gresley's " A4's " and Mr. Stanier's " Coronations " as completely streamlined types which were designed as such, the fairings fitted to the G.W.R. engines were only accepted as experimental additions to what already were beautifully proportioned machines. On the other hand, as a result of the " utility " policy, the Gresley greyhounds suddenly looked very wasp-waisted and cold about the knees, whilst on the L.M.S.R. the sight of a disrobed *Duchess* bustling along with cape-like smoke deflectors drawn tightly about her slant-topped smokebox could evoke nothing but sympathy.

Many surprises have been sprung upon the enthusiast in the new outlines of rebuilt locomotives. Some are pleasant indeed. Not only do they compare favourably with the original design, but sometimes they improve upon it. Unfortunately this has not been the result in all cases. For instance, with all allowance for the prejudice that we are bound to have in favour of the original design, many a sad head has been shaken in contemplation of a Thompson Pacific on the L.N.E.R. Why do I choose this type as a target for criticism ? Possibly because an artist finds it easy to appreciate the proportions of such a design as the original Gresley " A1 " or the " A3."

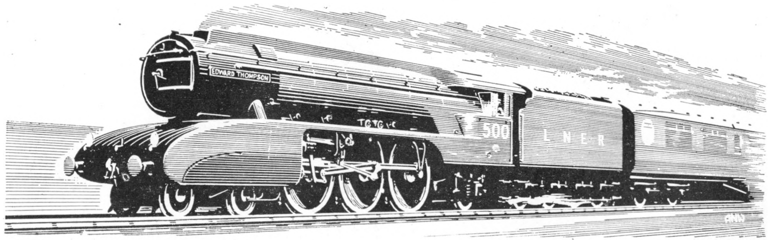
It is proportion that worries me when I look at an " A2," especially the new fellows with their flat-fronted cabs. Strangely enough, that cab looks all right on an " A3," but here it seems to hang precariously on to a lengthy boiler narrowed by high frames. Whilst the poor little dome, clinging shyly to the top line, the " Town Hall steps " for'ard and the vacant space beneath them, the vast smoke deflectors fitted to most of the engines and the flat-chested smokebox door—all combine to offend the eye. This criticism is no doubt severe when one considers the conditions in which the new type was built, and that in some ways at least it may be an improvement technically on its pre-

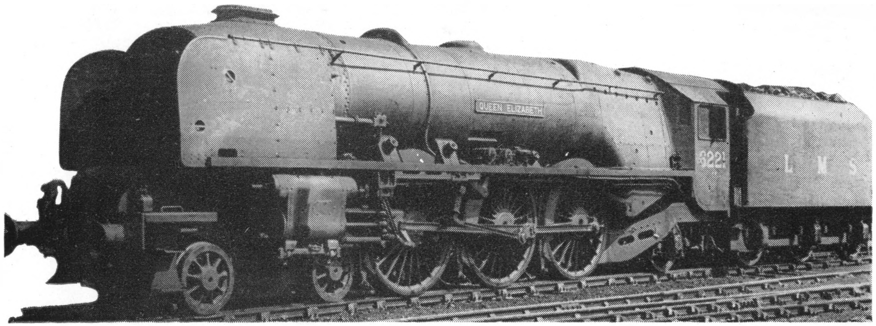


“ A QUESTION OF LINE ”



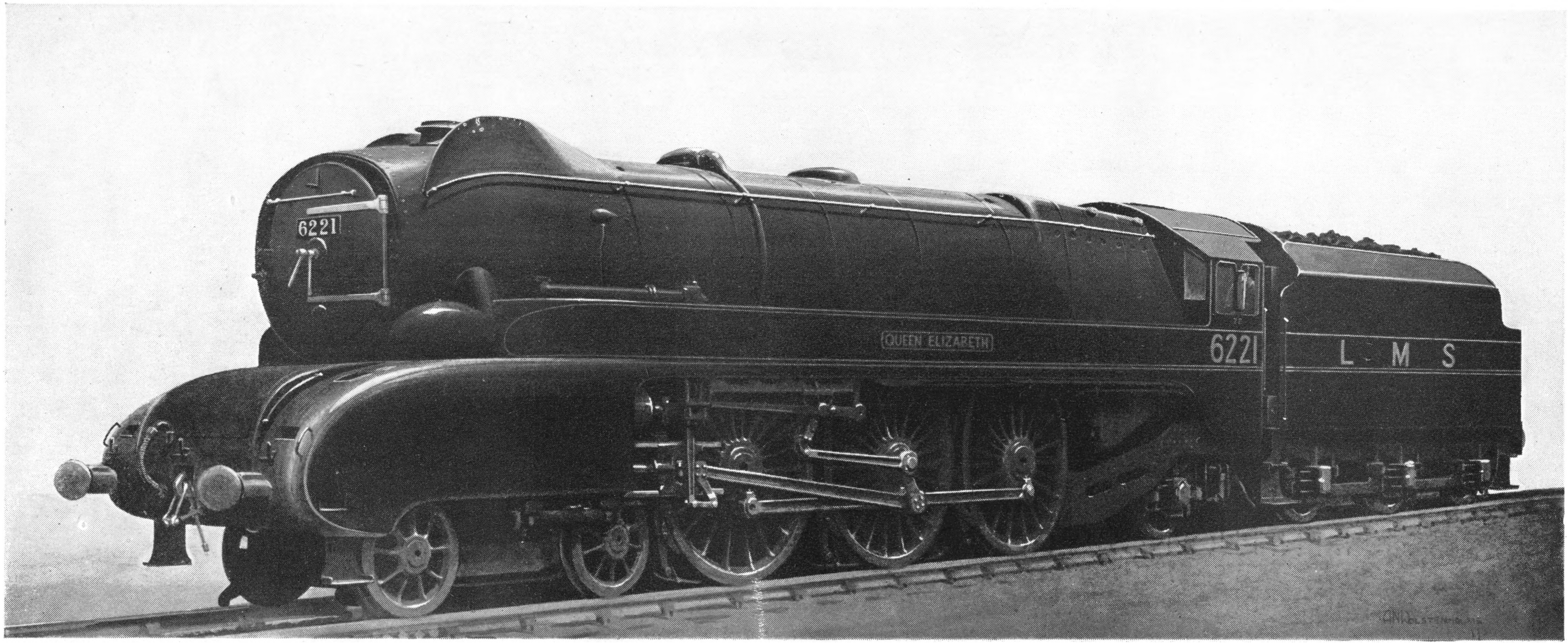
L.N.E.R. 6 ft. 2 in. Pacific No. 500, *Edward Thompson*, *above*, as now running, and (*centre and below*) as imaginatively modified and semi-streamlined by A. N. Wolstenholme





" A QUESTION OF LINE "

A de-streamlined " Duchess " Pacific of the L.M.S.R. (*left*) as actually running, and (*below*) with semi-streamlined exterior proposed by A. N. Wolstenholme



decessors, but as an example of British locomotive design the Thompson Pacific seems sadly lacking in character and a poor exchange indeed for the original Gresley model.

By voicing an opinion one invites argument, especially in matters of personal taste. To back up this opinion I have prepared a drawing, reproduced on p. 19, showing certain simple modifications of this L.N.E.R. 4-6-2 in the interests of appearance. The aim has been to balance up the proportions of the " A2 " into a clean, smooth-lined shape, and in so doing not to lose entirely the characteristic outline of British locomotive practice. At the same time cost, weight and accessibility have been considered. The alterations are assumed to be made during building, when modification of the top line of the forward frames and footplate can be carried out without difficulty. Naturally enough, such modifications might not be possible in present circumstances, but they remain as a suggestion of what could be done eventually to clean up a typical result of austerity without indulging in complete streamlining.

The footplate is swept downward following a line passing through the edges of the two original " steps " and the top of the buffer beam. Between the frames in front of the smokebox, the curved footplate hinges downward and inward from its leading edge to form a platform during smokebox cleaning or for easy access to the side footplates. Counterbalanced, it is lowered by pulling down a folding footstep mounted below the buffer beam adjacent to the coupling. The vacuum brake hose can be pulled out of its stowage when required after removing a dummy end plug which normally retains the hose in position.

The top edges of the front fairings will be seen to have a small radius, while the lower edges follow the curve of the cylinder block, much the same as the fairings of the " A4," but considerably longer. Note the necessity of splitting up the large, flat area by means of the black panel, the top line of which finishes level with the underside line of the rear frames. A touch of pomp goes with the well-rounded smokebox door, and all the boiler top fittings are enclosed in an almost flat-topped fairing, of which the forward end consists of deflectors similar to those fitted already to many of the " A2's." From the point of view of proportion, the main purpose of this new top line is to add depth to the boiler.

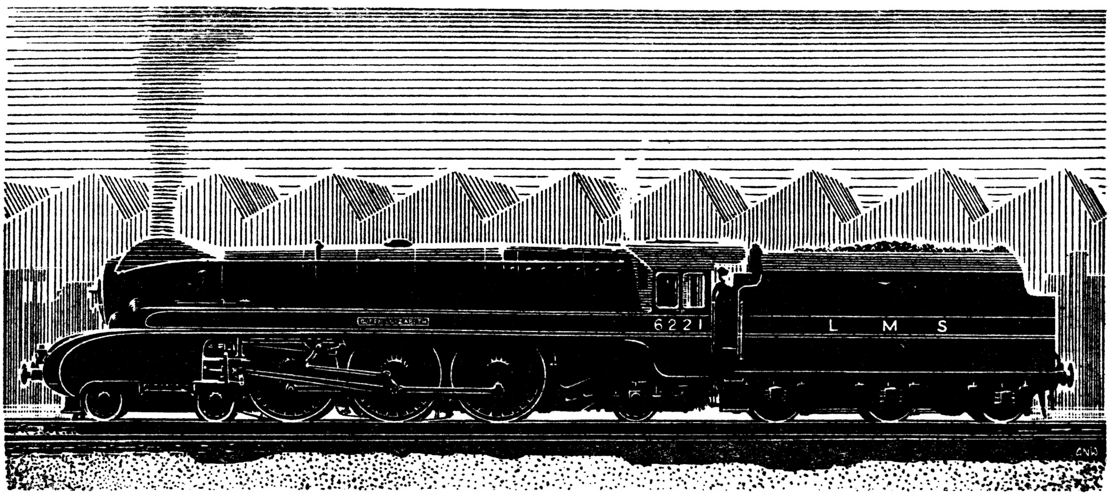
The cab is, perhaps, the most noticeable innovation. There is no change in the driving position, but the rounded front and the side of the cab are cut away to form a tunnel along the side of the firebox, terminating in a sloping windscreen fitted with a cleaning jet and a wiper. The effect is to bring the screen backwards from its present almost useless position to a point where it is shielded from the sun and rain and, being closer to the eye, is comfortable to look through. The rear part of the side window is glazed, but the open portion corresponds to the original rear window, and the usual wind deflector glass is fitted to the forward upright. Ventilator louvres can be opened in the top surface of the windscreen tunnel, and a broad sliding roof is provided in the roof of the cab. The smoothing process which has been applied here follows the basic principle of continuity of line. All the fairing curves, it will be noticed, are in sympathy with one another, as far as possible, and all vertical lines in the original design have been eliminated with advantage to the appearance.

In the drawing opposite, a variation of the scheme has been applied to the de-streamlined "Coronation" class of the L.M.S.R. In this case the treatment is simpler, as the original wedge-fronted cab is retained. The modifications comprise boiler-top smoke deflectors in place of the unsightly originals which, one feels, are disproportionately large for

the amount of use that they are; a fairing forward to enclose the undignified result of removing the streamline casing; and a roofless panel along each side footplate to conceal the present " marine stores " of miscellaneous fittings, whilst leaving these components easily accessible from above. The deflector assembly is built up on either side of the sloping smokebox top. It consists of an inner and outer surface, the former closing in towards the rear and curving round the back of the double chimney, which with advantage could be lipless. The outer surface leans inward at the sides, springing from the curve of the smokebox on a line followed by the handrail ; its rear portion sweeps down from the top lip behind the chimney, meeting the boiler at its junction with the smokebox.

To produce a pleasant curve for the forward fairing it is necessary to allow the centre cylinder block to occupy a slightly raised hump between the frames. The sides of this are flat and mounted on the vertical frames, which have their top corners rounded off a little. Fitted to these side surfaces are curved handrails for use with the footsteps let into the sloping footplate. The side panel commences at the steam-pipe casing, and curves outward, becoming flush with the edge of the footplate at the rear of the cylinder assembly. Forward of this point it is easily stepped over during servicing. It continues aft to join the cab, where a rising floor-plate, alongside the firebox, lifts the airstream upward across the windows. It would, in fact, be interesting to experiment with " smoke deflectors " of this sort, as the airflow on the inside of the panel, although troubled, would be quite considerable. At the rear end, the only alteration is a small fairing to reverse the frame curve at the bottom of the cab side-sheet into the under-line of the footplate. The lining is effective in its simplicity. All vertical lines have been omitted, and the forward curves on the side panel duplicate those on the fairing in a smaller scale.

These ideas are the outcome of a dissatisfaction with the shapes of the locomotives as they are at present, and represent some very interesting juggling with shapes, whilst keeping the result within the bounds of constructional possibility. The reader might care to experiment with the outlines of his own pet aversion, but in doing so he should bear in mind that the shape must be pleasant from whatever angle it is viewed. Moreover, whatever he thinks of the result himself, he will find many critics ready to assure him that it is, indeed, " All a question of line."



OIL-FIRING ON LOCOMOTIVES

By B. W. Anwell, B.Sc.(Eng.), A.M.I.Mech.E., A.M.I.Loco.E.

ALTHOUGH coal has been burnt almost exclusively in locomotive fireboxes in Great Britain for many years, it is well to remember that this is by no means the only fuel that can be used, or even the most suitable. For example, in the early days of locomotives, the usual fuel was coke, the reason being that people objected to the smoke produced by coal. In countries where coal is relatively difficult to obtain, such alternative fuels as wood or oil are used successfully in locomotives.

In Great Britain, for many years coal was taken for granted as the most suitable locomotive fuel, not only because it was relatively cheap, but also because the coal available was of very good quality. There have been occasions, however, when oil has been used. In 1893, the Great Eastern Railway found that the spent oil from their plant at Stratford which produced the gas for carriage lighting could be burnt very successfully in locomotives, and it provided a very cheap source of fuel ; but when 50 to 60 locomotives had been fitted, the original source could not supply enough oil to meet all requirements and oil had to be purchased. This soon became too expensive as compared with coal and eventually the use of oil on the G.E.R. was discontinued.

Other periods of conversion to oil fuel occurred both before and after the First World War, when a series of coal strikes caused the coal stocks of the railways to become very depleted, and many railways converted a number of their engines to burn oil. This conversion was partly in order to obtain some experience of its use, and partly to have a few locomotives at least that could be kept in service should their coal supplies become completely exhausted.

The reason for the present oil burning conversion schemes is the difficulty of producing sufficient coal to meet all the demands ; the railways, in common with other industries, are unable to get as much coal as they would like. Moreover, not only are their supplies restricted, but the quality of the coal that they can obtain is much inferior to that which they have used in the past, and for which most British locomotives are designed. The results of using inferior coal have been very marked during the past few years by the inability of locomotives to maintain full steam pressure, with resultant bad timekeeping or even more serious consequences.

A particularly bad sufferer from the poor coal available has been the Great Western Railway, most of those engines are designed to use high quality Welsh coal ; it is fitting, therefore, that the G.W.R. was the first to begin this latest series of conversions, in October, 1945, by altering a 2-8-0, No. 2872, to burn oil fuel. After various " teething troubles," the use of oil proved quite satisfactory, and it was decided to carry out a number of further conversions. In August, 1946, owing to the continued deterioration of the coal situation, the Minister of Transport announced a large scale conversion programme covering all four main line groups, involving 1,217 locomotives, and about 58 locomotive depots at which they would be stationed. The majority of engines to be converted are of freight classes, over half being of the 2-8-0 type, but the programme includes " Hall " and " Castle " class 4-6-0 engines of the G.W.R., and S.R. " West Country " class 4-6-2's.

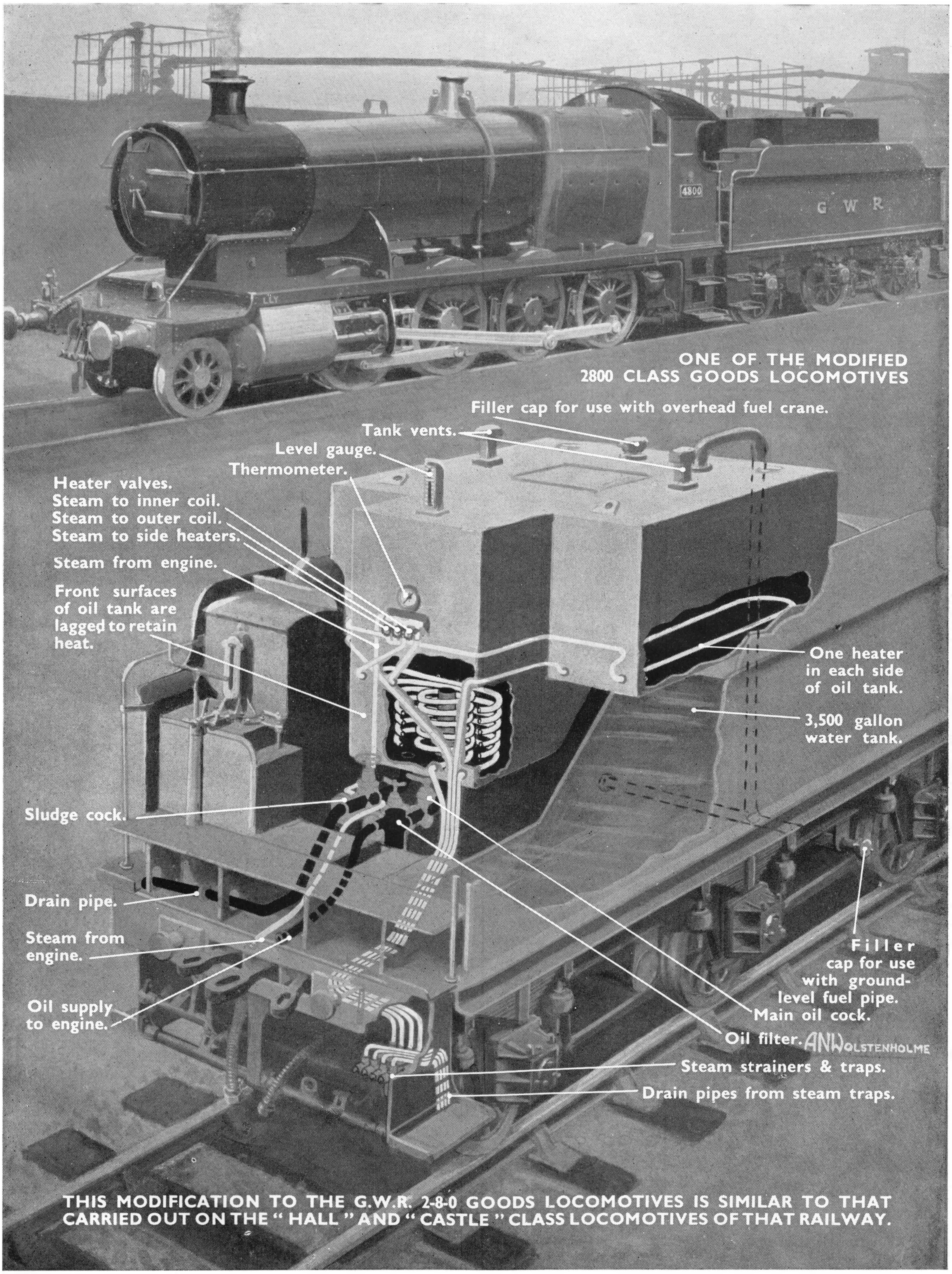
The oil fuel apparatus developed by the G.W.R. is being used by all four railways, so let us examine it in more detail. Externally the appearance of the engine is unaltered, except for the oil tank on the tender, which occupies the coal space. This tank is readily removable, should the engine be required to burn coal once more, and it is provided with a filling hole in the top, and also with a system of pipes from the top of the tank to couplings, at axle height, for connecting to filling hoses at ground level. Inside the tank are a number of coils of pipe through which steam may be passed in order to warm up the oil in the tank, because the oil used for burning in locomotives is very thick and sticky at ordinary temperatures, and it is important that it should be warm if it is to flow freely from the tank to the burner on the engine. Control valves are provided on the front of the tender to control the flow of steam through the various coils, and a thermometer, mounted on the front of the oil tank, shows the temperature of the oil.

From the oil-tank, the oil flows through a stop valve below the tank, then through a filter, provided to intercept any dirt in it, and finally through a flexible hose-pipe to the engine. The oil-pipe runs underneath the cab, and continues below the platform until it reaches the burner, which is mounted just inside the front of the firebox. Where the oil-pipe runs along underneath the platform, it is enclosed by a larger pipe, and steam can be passed through the space between the two, which is closed up at each end of the outer pipe. This forms an auxiliary heater for the oil in case the tender heaters are unable to keep it sufficiently fluid.

At the front of the auxiliary heater is mounted the oil fuel control valve, which regulates the flow of oil to the burner ; this is operated by rods from a control column situated inside the cab, just in front of the fireman. To obtain a fine adjustment, the oil fuel control handwheel operates the valve through a gear-wheel and toothed sector, thus making it necessary for the handwheel to make several complete turns to open the valve from the closed position, while at the same time the position of a pointer on the sector plate gives a clear indication of the extent to which the oil-valve is open.

The burner itself is of the " weir " or " Mexican trough " type, and is designed so that the oil does not have to pass through any small holes or passages which might become blocked in service. It comprises a rectangular oil passage above a similarly-shaped steam passage, at one end of which are connections for coupling up to their respective pipes. At the opposite end the oil passage finishes in a rectangular hole about 2 in. wide, and immediately below this is the steam outlet, which is a horizontal slit, a little wider than the width of the oil opening, and only a small fraction of an inch deep. Its operation is very simple. Oil flows through the upper passage and through the hole at the end in the form of a " ribbon." Steam, issuing from the slit under pressure, strikes the ribbon of oil and breaks it up into a spray, which is then carried by the steam into the centre of the firebox, where it ignites readily.

The burner is mounted near the bottom of the firebox at the front end, and the flame is directed towards the back wall of the firebox, just below the firedoor. To protect the lower part of the firebox from the concentrated heat of the flame, brickwork is built up against the sides and ends, with a specially thick wall underneath the firedoor. As there are no ashes to be disposed of, the space across the bottom of the firebox which is normally occupied by the grate is covered by a plate upon which rests a layer of brickwork with several air holes through both the plate and the brick. The burner itself is surrounded by a " pocket " of brickwork, so that it is partly protected from the heat of the flame.



THIS MODIFICATION TO THE G.W.R. 2-8-0 GOODS LOCOMOTIVES IS SIMILAR TO THAT CARRIED OUT ON THE " HALL " AND " CASTLE " CLASS LOCOMOTIVES OF THAT RAILWAY.

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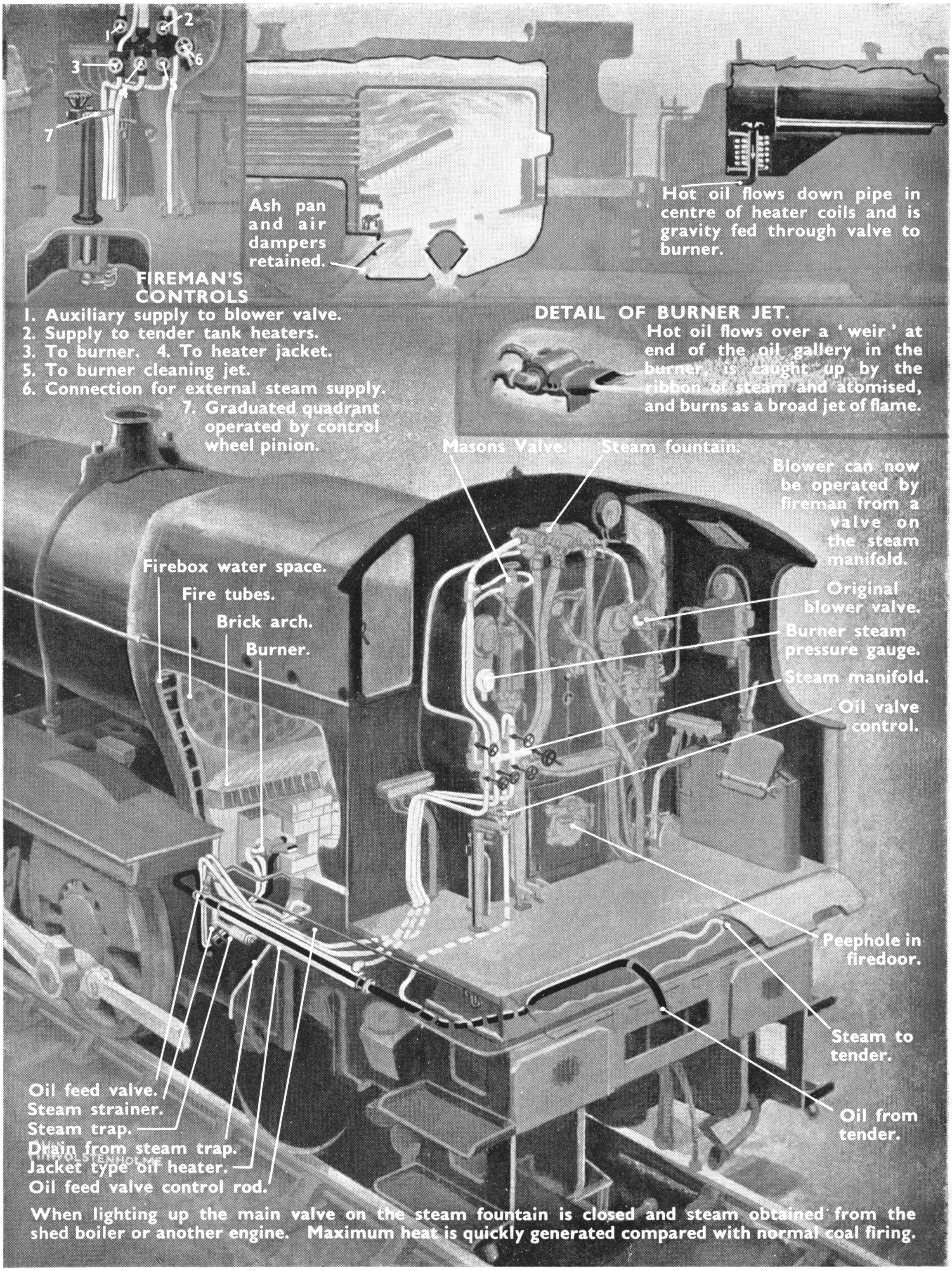


When lighting up the main valve on the steam fountain is closed and steam obtained from the shed boiler or another engine. Maximum heat is quickly generated compared with normal coal firing.

Air, for the combustion of the oil, is drawn into the firebox through an air-hole surrounding the burner, and through the holes in the firebox bottom. The same ashpan as that used for coal-burning is retained, but its only use is to form an air duct into the firebox, using the original damper doors to control the amount of air passing through it. The normal type of firehole, through which the coal is fired in a coal-fired engine, is replaced by a plate, bolted up in position, with a small hole covered by a flap through which the flame can be observed from the cab.

To provide steam for heating the oil tank, atomising the oil, and so on, an oil-burner needs additional steam supplies, as compared with a coal-fired locomotive, and for these a steam " manifold " is mounted on the back of the firebox inside the cab ; to this are attached a number of valves, with their corresponding pipe connections, all within easy reach of the fireman. The manifold is connected to a steam-valve on the boiler, through which steam is supplied when the boiler is under pressure, and it also has a connection for coupling up to a flexible pipe through which steam can be supplied from another locomotive or from a stationary boiler. The external supply of steam is needed when the " cold " engine is being lit up, for the oil must be heated and the steam jet in the burner in operation, as well as the blower in the smokebox for creating a draught, before the boiler can raise enough steam to provide for these requirements itself.

The valves on the manifold control the supply of steam to the burner, the tender heating coils, the auxiliary heater, the burner heater and the blower, while valves are also provided to shut off the steam supply from the boiler and the external steam connection. The steam for cleaning the burner, which has not previously been mentioned, is let into the oil space at the back of the burner and is turned on for a short while before lighting up and after shutting off. A steam pressure gauge also is provided near the manifold to show the pressure of steam passing to the burner.

Although this type of equipment is being used for all engines that are being converted by the four main line groups under the Ministry of Transport scheme, there are other systems which, while similar in many respects, differ in the design and position of the burner. One of these is used on some 4-4-2 tank locomotives of the Great Northern Railway (Ireland) and has the burner standing vertically in the centre of a plate covering the firebox bottom. A number of advantages are claimed for this scheme, but it has the disadvantage of a more complicated burner, with small oil passages.

Let us now see how oil firing affects the operation and performance of a locomotive, and to do so let us, in imagination, make a trip on one. The engine will be waiting for us in the shed, with steam raised, but at considerably less than full boiler pressure, and with the oil supply adjusted to produce the smallest possible flame. Already the oil and water tanks will have been filled, and as soon as the driver has examined the engine, it will be ready to leave the shed. On getting the signal, the engine will depart for the sidings to pick up its train, and no more than a small increase in the quantity of oil flowing will be needed to produce enough steam for running light.

After coupling on to the train, the fireman will increase the oil supply in order to produce the full pressure of steam in the boiler, but he may have to shut down the supply again if full pressure is obtained before the train gets the signal to start, to avoid wasting steam by blowing off through the safety-valves. On starting, the fireman will adjust his oil control to maintain the boiler pressure at its full value, and here his knowledge of the route will be needed, for the oil supply must be adjusted to suit the varying demand on

the boiler for steam, caused by alterations in gradient, speed restrictions, and when coming to a stop.

In this respect, an oil-burning engine requires rather more skill on the part of the fireman than a coal-burner, for in the latter case the fire can be built up in readiness for a heavy demand for steam, say before climbing a gradient, and when the engine starts to climb with the regulator opened more widely, the increased blast that results will cause the fire to burn more rapidly and produce the additional steam more or less automatically. With oil, however, the strength of the blast makes little difference to the rate at which the oil is burnt, and the supply must be adjusted whenever the driver moves his regulator or " notches up." The fireman could leave the burner on with a full supply of oil all the time, of course, but this would result in waste of oil, and might damage the firebox.

One great advantage of the oil-burning locomotive, however, is that it can produce steam at the maximum rate for an indefinite time, whereas a coal-burning engine needs to have the fire cleared of clinker and ash after a time. The fireman, too, would not be able to shovel coal at the maximum rate at which it could be used in a large engine, for more than a limited time.

It may be mentioned that each alteration to the position of the oil-control valve requires an equivalent adjustment of the steam supply to the burner to produce the most satisfactory length of flame. The position of the dampers, too, may need alteration to permit the correct quantity of air to enter the firebox, and if this is not done properly, thick smoke will start to issue from the chimney.

On finishing the trip, the burner will be shut down to produce just sufficient steam to take the engine back to the shed. On arrival, the oil and water tanks will be filled, the burner turned right out, the steam supply to the oil heaters turned off, and steam will be passed through the oil passage of the burner to clean it out. The dampers will be tightly shut to prevent the firebox cooling down too rapidly, and the engine will be ready for lighting up again some little time before starting out on its next trip.

How does the use of oil fuel affect the running sheds ? First of all, oil storage tanks have to be provided, and sidings must be available close to them for the oil-tank wagons from which they are filled, as well as for the locomotives taking fuel. All these must be as far away as possible from the place where the fires of coal-burning engines are dropped, to prevent the possibility of fire. Secondly, in order to keep the oil warm so that it will flow freely out of the storage tanks, steam-heating pipes are required in the tanks, and a boiler must be provided to supply the necessary steam unless steam is available from any other source. A pipeline also is needed, to which hoses can be coupled for supplying steam to the steam manifolds of engines in course of being lit up. Special sidings on which engines can be stood while raising steam are needed, with the pipeline running alongside them and connections for the flexible hoses at frequent intervals. Steam from the boiler also may be used for working the pumps which pump the oil from the tank wagons into the storage tanks, and from these into the locomotives.

All this equipment takes up a considerable amount of room, although a great saving in space would result if no provision had to be retained for coal-burning locomotives as well. At the present time, the installation of suitable shed equipment has proved so difficult that the conversion scheme has been very much delayed, as it is obviously useless to convert large numbers of engines to burn oil if no facilities are available for dealing with them at the sheds.

Yet another problem, although not quite so difficult as some, is the provision of oil tank wagons for conveying the oil to the running sheds. The large number of open wagons used for bringing coal to coal-burning engine-sheds is some measure of the number of oil tank wagons that will be required for transporting fuel oil for over 1,200 locomotives, even though the average oil tank wagon holds the equivalent of about two wagon-loads of coal. In addition, every one of these tank wagons needs to be equipped with heating pipes inside the tank and steam-heating connections for coupling to adjacent wagons or locomotives, similar to those used on passenger coaches.

By way of commentary on the foregoing, some details supplied by Mr. Cecil J. Allen of a recent footplate trip on G.W.R. No. 5039, *Rhuddlan Castle*, one of the four engines of this class fitted to burn oil fuel, by the kind permission of Mr. F. W. Hawksworth, Chief Mechanical Engineer, G.W.R., are of particular interest. The train concerned was the 3 p.m. from Bristol to Paddington, and although the schedule is easy enough, the load, after Swindon especially, was substantial, and some very fast running was made between stops. " The first impression made on anyone familiar with the footplate," Mr. Allen writes, " is the fact of the permanently closed and sealed-up firedoor, and the tender front from which no coal is ever taken. The second, as you have described, is that the fireman, though relieved of the physical labour of firing and comfortably accommodated on a padded seat, has to concentrate more closely on his work than with manual firing.

" The enginemen with whom I rode were Driver Pollard and Fireman Green, of Old Oak Common shed, and the *liaison* between them was perfect. Every movement of the engine regulator and cut-off was accompanied by a suitable variation of the fireman's oil and steam controls, and the fireman was particularly alert to shut off the oil feed directly the regulator was closed. The efficiency of his work was measured by the colour of the smoke issuing from the chimney, and the dampers were adjusted from time to time to control the air supply to the firebox. Throughout the journey the steam pressure was maintained without the slightest difficulty at the 225 lb. mark.

" Out of Bristol we had a ten-coach train of 310 tare tons, or 330 tons gross ; from Swindon it was increased to 346 tare tons, or 370 tons in all behind the engine tender. One smart piece of work was when we mounted Dauntsey bank—2 miles at 1 in 100—with no greater drop in speed than from 60 to 51 m.p.h. ; here the engine regulator was full open and we were cutting off at 20 per cent. On the easy grades beyond Swindon, 15 per cent. cut-off soon raised the speed to 70 m.p.h. ; and from Maidenhead to Slough the engine ran freely at 71½ m.p.h. on the level with 17 per cent. cut-off.

" Among the lively start-to-stop times made was one of 15 minutes, 30 seconds for the 13.4 miles from Swindon to Challow, and another of 13 minutes, 23 seconds (13 minutes net) for the 10.8 miles from Challow to Didcot ; we should have covered the 16.7 miles from Chippenham up to Swindon in 20 minutes, but for a signal check. The brightest running of all was when we passed Southall, 26.9 miles from Reading start, in 27 minutes, 7 seconds. It was an impressively efficient performance."

The full meaning and extent of the oil-burning conversion scheme in this country may now perhaps be realised, and the reason for its estimated cost of many thousands of pounds appreciated. If i achieves nothing else, let us hope that, as far as oil-burning locomotives are concerned, we shall never again hear that age-old excuse for late running —" short of steam ! "

THE GREAT CENTRAL BETWEEN TWO WARS

By Basil K. Cooper

SINCE women porters became a commonplace between Harrow-on-the-Hill and Aylesbury, it is less usual to hear the station staff speak of a train as a " Central." A Marylebone train is now more generally called a " steamer," and often referred to in terms of disparagement for its habit of leap-frogging certain stations in a manner perplexing to the female mind. As for the rare services that penetrate beyond the well-ordered confines of the London Passenger Transport Board, the names of their improbable destinations rarely disturb the peace of suburban platforms in the off-peak hours ; and some guarded allusion to its schedule, such as " next stop Aylesbury," is all that a Manchester express must expect.

Even when the full pre-war service was in operation, the moments when the Metropolitan & Great Central Joint line took on the aspect of a main route to the Midlands and North were somewhat rare. To select and enjoy them was therefore a pursuit on a different plane from observing traffic on a heavily-occupied line, with anticipation having to contribute much to the pleasure.

It is a peculiarity of the Great Central main line to London that it approaches Marylebone by alternative routes, so that not only is the rather sparse traffic divided from the observer's point of view, but the dweller on either line is harassed by the uneasy suspicion that the more interesting locomotive classes are slipping by unobserved on the other. This is largely a fallacy, although the fact that the long-distance goods traffic is concentrated on the Great Western & Central Joint line *via* High Wycombe gives that section an advantage in some respects.

My own recollections of the Great Central are all of the London end of the line, which might well be a different railway from the same system north of Nottingham. Its peculiarities strike different people in different ways. Recently, for example, I was talking to a passenger guard at Marylebone who had been transferred a short time before from the G.N. section, and was leaving on a slow train to Woodford and Hinton. " Not a siding all the way down," was his critical comment ; then his eyes lit up as he recalled the Great Northern main line between King's Cross and Peterborough in laudatory terms. My own impression is that the first Great Central train I saw was a Manchester express passing Rickmansworth hauled by a " Sir Sam Fay " class 4-6-0, some time in the early 1920's. Probably I was influenced by pictures I had seen of *Sir Sam Fay* himself in a famous model-maker's catalogue, and it is more likely that my first G. C. express was in charge of a " Director " or an Atlantic, both of which classes were still painted green in those days.

At that time the rare appearances in the south of the large Robinson express passenger 4-6-0's made them seem almost fabulous monsters. A small boy at school claimed

to have observed *Sir Sam Fay* working a goods train through Amersham, thereby earning for himself a certain amount of respect, until he overstepped the mark with a further astounding invention and was thenceforth discredited. His new story was that a Gresley " Shire " had been seen at Harrow-on-the-Hill on an up slow from Woodford and Hinton. This in itself may not have been impossible, but the report was said to have come from his aunt. It is not usual for aunts to take engine numbers, however desirable the practice would be from the point of view of boys marooned at a boarding school far from their favourite main line. There may be in existence somewhere a contemporary enthusiast's notebook that would corroborate his report and vindicate his aunt for all time ; nevertheless he was disbelieved.

There was little difference between the Marylebone express service in the 1920's and that of 1939 (or of 1947, for that matter, before the coal crisis again curtailed it, and considering the number of trains rather than their timings). There was even then the long gap in main-line departures between 12.15 and 3.20 p.m. This persistent feature seems to date from the 1914-1918 war, for the summer timetables of earlier years show a service from Marylebone at 1.40 p.m. to Aylesbury, Leicester, Nottingham, Sheffield, and Manchester. In the very first G.C. London service, coming into operation on March 15th, 1899, there was a buffet car train to Manchester at 1.15 p.m., preceded by a Leicester slow at 12.15 p.m., but in those days the interval occurred in the afternoon, for the 3.20 had not made its appearance and there was nothing more until 5.15 p.m.

In the 1920's, apart from the usual Manchester and Bradford trains, there was a through restaurant car service to Mansfield at 5 p.m. This was diverted to Sheffield in later years, and finally terminated at Nottingham with the introduction of the 4.55 p.m. Manchester train. An up service from Mansfield remained in being, however, until 1939. For some years this brought up the through coach from Stratford-on-Avon which was taken down as a Woodford slip (together with a slip for Finmere) on the 6.20 p.m. Through workings to Stratford disappeared with the withdrawal of the slips in 1936, but the connections have remained.

The manner in which they are maintained is unusual. The L.M.S.R. train from Blisworth reverses at Byfield to run down the spur to Woodford, where it picks up passengers coming from the London direction on the 4.55 p.m. slow from Marylebone, and awaits the arrival of the afternoon train from Manchester. It then proceeds to Stratford, calling again at Byfield. During the war, the station staff at Byfield used to call " Change for Stratford " when the train arrived from Blisworth, so that passengers who acted upon this instruction were liable to find their former seats occupied when the same carriages returned from their sojourn at Woodford ; moreover, to those in the know, the Woodford refreshment room was an added inducement for staying on board.

Regular through carriages from Marylebone to the north-east of England were withdrawn in the 1914-1918 war, and the subsequent grouping made them redundant. The development of such services had been considered seriously in Great Central days, for soon after the London line was opened the company proposed seeking powers to build a direct link from Beighton to Rotherham and Masborough, in order to shorten the London-York journey as compared with the existing route avoiding Sheffield by the Darnall curve. It was not proceeded with, and services to the North Eastern Area since grouping have been run mainly with the object of relieving the East Coast main line. Through coaches from Marylebone to York were provided in the 1920's on a period

excursion train for Manchester and Liverpool which ran on Saturdays in summer, leaving at 10.45 a.m. and taking the Aylesbury route. The period excursion disappeared with the coming of the monthly return ticket, but the later introduction of special cheap fares for night travel resulted in the operation of a through Marylebone-Newcastle service from 1937 until 1939.

Various places on Great Central metals, which before the 1914-1918 war enjoyed through carriages from Marylebone, lost them after grouping because they could be reached more conveniently from King's Cross or Liverpool Street. There was no revival, therefore, of the through carriage to Lincoln that was shown in the summer time-tables of 1915. Detached from the 3.15 p.m. down at Nottingham, it was taken forward along the main line non-stop to Heath, diverging shortly afterwards over the Duckmanton curve, which connects with the Chesterfield to Lincoln line of the one-time Lancashire, Derbyshire & East Coast Railway. The more direct connection from Nottingham *via* Mansfield, connecting with the L.D.E.C. line at Warsop, had not then been completed.

Cleethorpes, also, did not have its through connections with London restored after the 1914-1918 war. Right up to 1939, however, the 3.20 down Manchester was followed out of Leicester by the through train to Cleethorpes that once took the Marylebone carriage forward, avoiding Sheffield by the curve at Waleswood. This connection from London to Cleethorpes was considered worthy of a place in an L.N.E.R. pocket A.B.C. time-table published in the 1920's. During the summer months of the late 1930's, passengers on the " Met " could often see coaches labelled " Orient Line Cruise Special " standing in the sidings at Neasden. These were run in connection with sailings from Immingham, usually as portions of the regular trains between London and Sheffield. The 7.30 a.m. up Sheffield express sometimes served as a " boat train " in this way.

For years, as it seemed to me, time-table followed time-table without bringing any material change or increase of service. Depression deepened when the " Directors " and the Atlantics lost their green paint, for even the least instructed beholder in Metroland had learned to distinguish a long-distance express from a local service by the colour of its locomotive. The G.C. route to the north received little publicity in other ways. Even the inclusion of the 10 a.m. to Bradford in the L.N.E.R. route-diagram poster, " The Three Ten o'Clocks," was suspected to be on account of the accident of departure time rather than in the sincere desire to attract travellers to Marylebone as a gateway to the North.

At one time there had been the slogan, " Marylebone for the Midlands," which I first saw adorning a tub containing an ornamental shrub on the platform at Croxley Green Station on the newly-opened Metropolitan & L.N.E.R. branch to Watford. Soon after this opening, in 1925, a pocket time-table folder was issued giving connections from Watford to the Midlands. There was one each way daily with a Manchester restaurant car express at Northwood. The remainder entailed using the " Met " shuttle service between Watford and Rickmansworth (since withdrawn), and usually changing again at Aylesbury or Brackley. This was the nearest approach to the through services hinted at in speeches at the opening ceremony of the Watford line. The L.M.S.R. responded by inserting a stop at Watford Junction in the schedule of the midday semi-fast to Crewe, giving connections for Liverpool and Manchester.

On one or two occasions since, there have been through excursions from Watford Met. & L.N.E.R. station to Leicester and beyond, the engines working tender first from

Neasden to Watford, and running round their trains there. The Watford-Marylebone service, put on when the branch was opened, was of short duration. It was revived once, and then lapsed apparently *in perpetuo.*

Locomotive matters became more interesting about 1930, when for a time "Lord Faringdon" and "Sir Sam Fay" 4-6-0's alternated regularly with "Directors" on the 8.45 a.m. and 3.20 p.m. down and 2.15 p.m. up Manchester expresses. After a further relapse to four-coupled types, there came the gradual introduction of the "Sandringham" 4-6-0's, reaching its peak with the advent of the "Football" series of these engines, which were stated officially to have been built for the services between Marylebone, the Midlands, and the North.

Various accelerations had taken place in the long-distance trains, and by now the 4.55 p.m. down had come to oust the 3.20 from its position as the fastest service on the line to Leicester, by cutting its 1 hour 49 minutes to 1 hour 48 minutes. Yet the 4.55 clung to its "Director" for some time after the 3.20 became regularly "Sandringham"-hauled. It was a light train, of five or six coaches, whereas the 3.20 regularly took seven on account of the through L.M.S.R. vehicle on the rear for Halifax.

These were the days of strenuous efforts by the railways to regain traffic lost to the roads. Loads on the Marylebone line began to increase, for at last the terminus began to receive some overdue publicity. Readers will remember the large posters, handbills, and newspaper announcements advertising Sunday half-day excursions, with buffet cars and seat reservation facilities. Sometimes these were combined with road trips from Rugby to the Shakespeare country, or from Nottingham to the Dukeries.

Often in the summer, three half-day excursions were despatched from Marylebone within a quarter-of-an-hour, loading to ten bogies or more, and disturbing the Sunday morning calm of Buckinghamshire as they snorted up the bank to Amersham behind a Caprotti-fitted "Lord Faringdon," a "Sandringham," or one of the four-cylinder mixed traffic 4-6-0's. If this seems an unprecedented density of traffic, what of the nights before Bank Holidays, when the cheap fare trains to Newcastle streamed down the double track to Neasden at short intervals from nine o'clock until the small hours, and, with an occasional "Green Arrow" or "A1" Pacific, gave a foretaste of a locomotive revolution in store?

Apart from the various cheap travel attractions, which on special occasions included also the working of football excursions between Scotland and Marylebone, there is no doubt that the interavailability of tickets with the Midland route must have brought many passengers to the Great Central London line who otherwise might not have used it. The loads of the regular trains, particularly at weekends, went up to ten coaches or more, and at length the installation at Marylebone of a longer turntable capable of handling Pacifics and "Green Arrows" raised expectations of time-table novelties. Previously it had been necessary to turn engines of these dimensions by running them round the Stadium Station loop at Wembley.

The first "A1" Pacific appeared regularly on the line at the end of 1938, soon followed by others, and by "Green Arrows." It was rumoured once that a bowler-hatted figure had been seen on the footplate of *Tracery* as it cautiously edged its way round the curve at Rickmansworth—some dignitary of the locomotive world gathering data for the introduction of a new "Sheffield Special"? But these expectations were brought to an abrupt end in September, 1939, and the new resurgence of Marylebone

was checked even more drastically than the earlier tide of Great Central development had been by the First World War.

Although outside the period defined by the title of this chapter, some features of the war years cannot be passed over. Twice Marylebone was temporarily isolated, once by a bomb on the approach tunnels, and later by a " doodlebug " which severely damaged the signalbox. Temporary platforms were built at Neasden at one period so that trains could terminate and start from there. Despite the severely limited train service, the G.C. line was heavily patronised by thousands of Service men and women who were stationed in the sparsely-populated districts between Aylesbury and Leicester. Booking clerks at country stations found themselves regularly besieged at week-ends by holders of 48-hour passes setting out on journeys that would daunt the imagination even of a student of " Bradshaw."

The " A1 " Pacifics soon disappeared from the section, and their place was taken for most of the war by " Green Arrows." Three Caprotti-fitted " Lord Faringdons " had a long innings at Neasden, mainly working stopping trains to and from Leicester. In the later war years the first of the new Thompson " B1's," *Springbok*, saw a period of service with the Manchester trains, as a prelude to the extensive use of these engines on the G.C. section at the present time.

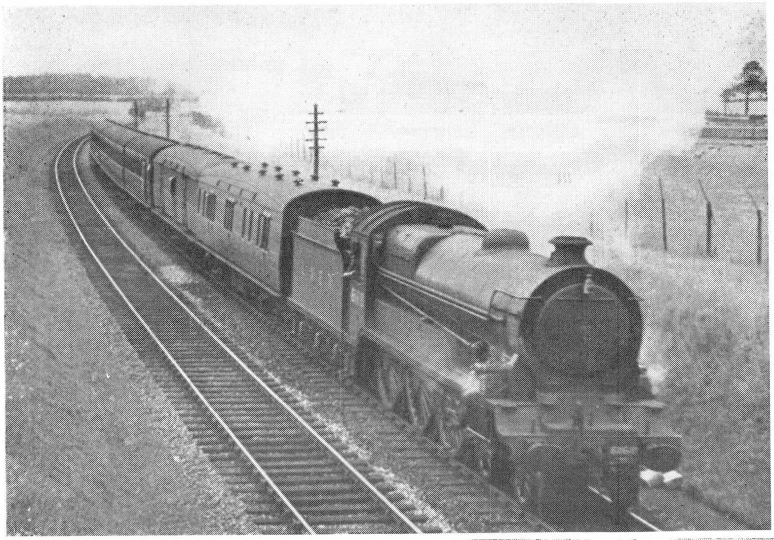
Through all these changes and right up to the present date, the London suburban trains have continued to be handled by the Robinson 4-6-2 tanks. Other types, including the new " L1 " 2-6-4, have appeared spasmodically, but the old " Coronation " tanks give no sign of being ready for retirement. It is an odd fact that the only lasting change in G.C. suburban working of recent years has been the return to the London area of the still older Robinson 4-4-2 tank engines. They came south in 1937, when the L.N.E.R. took over all the steam workings, passenger and goods, on the Metropolitan joint line north of Richmansworth. The 4-4-2s work the Chesham branch, and run through to and from Marylebone on certain trains.

Local goods traffic on the Aylesbury line has been worked since 1937 by Robinson 2-6-4 tanks, which exchange their loads at Quainton Road with trip trains running between there and Woodford and Hinton. This is one of the many aspects of railway operation for which the interested observer politely supposes that there must be a reason other than habit, although it is not apparent to him. It would seem that with the whole of the workings now in L.N.E.R. hands, the " Met " engines might well continue to and from Woodford themselves.

The G.C. main line to London may not be regarded with much favour by to-day's tidy-minded planner of transport. As a last and admittedly audacious fling of railway construction by private enterprise, it is likely to be suspect, and various sober and unprejudiced writers on railway topics have come to the conclusion that under a State-directed system it would never have been built. Another school of thought may hold that under State planning a hundred years would not have sufficed to provide us with any main lines at all, let alone one too many !

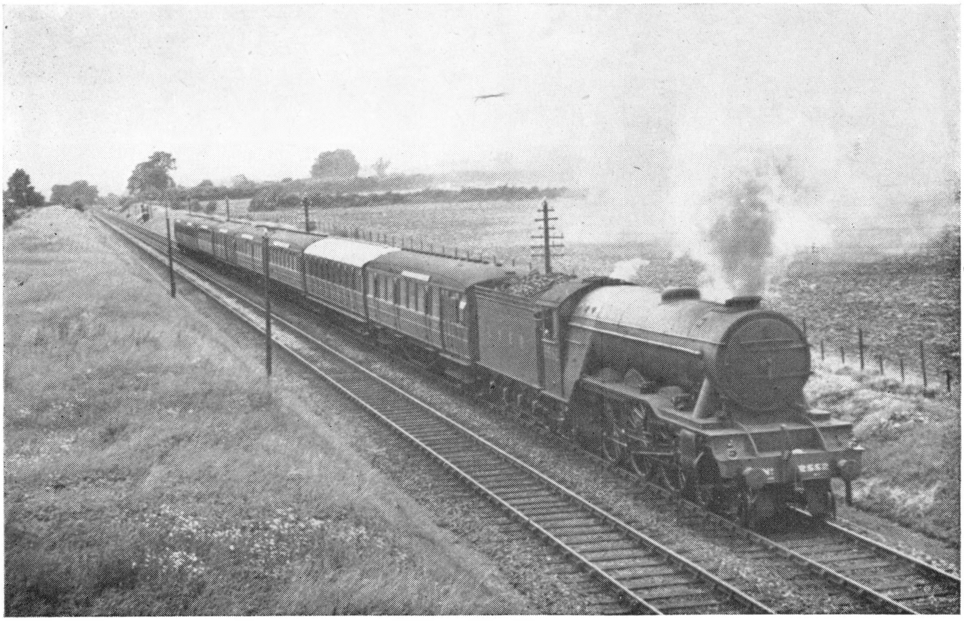
On the other hand, perhaps the line will be " discovered " by some enterprising Civil Servant in search of fresh empires to build (as the phrase runs in Whitehall itself), and elevated to an importance never attained in the past. It would be a curious outcome if the result were to be the unearthing of Sir Edward Watkin's project for through trains from Manchester to Paris by way of a Channel tunnel !

" THE GREAT CENTRAL BETWEEN TWO WARS "



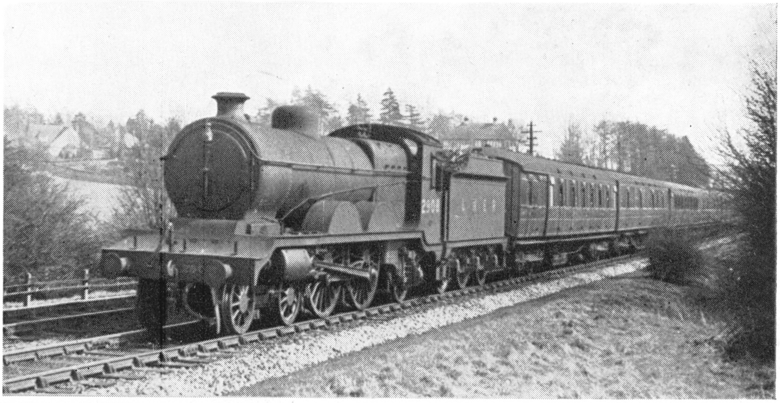
Left : An up local near Great Missenden is hauled by Class "B3/2" 4-cylinder 4-6-0 No. 6168, *Lord Stuart of Wortley* (since withdrawn). The engine is seen as rebuilt with Caprotti valve-motion [*H. C. Casserley*]

Right : Up Manchester Express passing Bagthorpe Junction, north of Nottingham, with Class "D11" ("Director") 4-4-0 No. 5504, *Jutland* (since renumbered 2668) [*Rev. A. C. Cawston*]



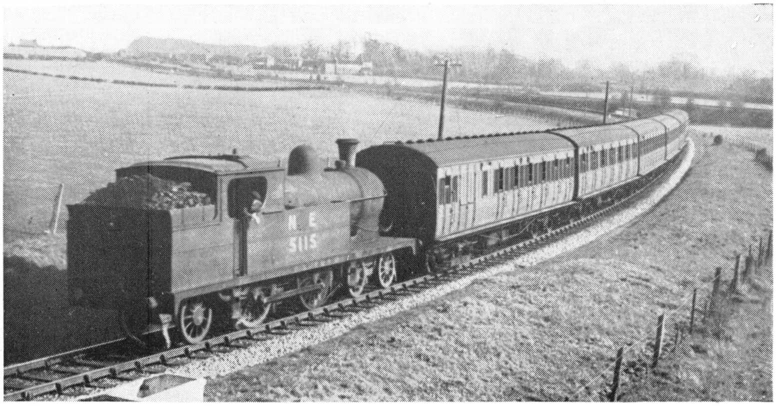
Left : The Pacific era. Class "A1" 4-6-2 No. 2552, *Sansovino* (since rebuilt to Class "A3" and renumbered 53) is shown near Stoke Mandeville with a Marylebone—Manchester express [*H. C. Casserley*]

Left : At Moor Park—" B17 " 4-6-0 No. 2848, *Arsenal* (now 1648) approaches Moor Park with an up express from Bradford to Marylebone [*B. K. Cooper*]



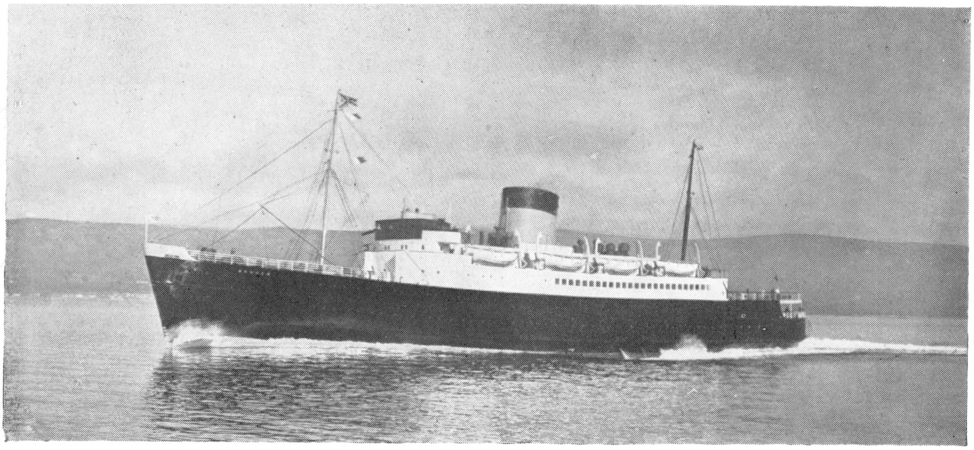
Right : A Robinson Atlantic, No. 2908 of Class " C4 " (previously 6084) with a stopping train near Rickmansworth [*H. C. Casserley*]

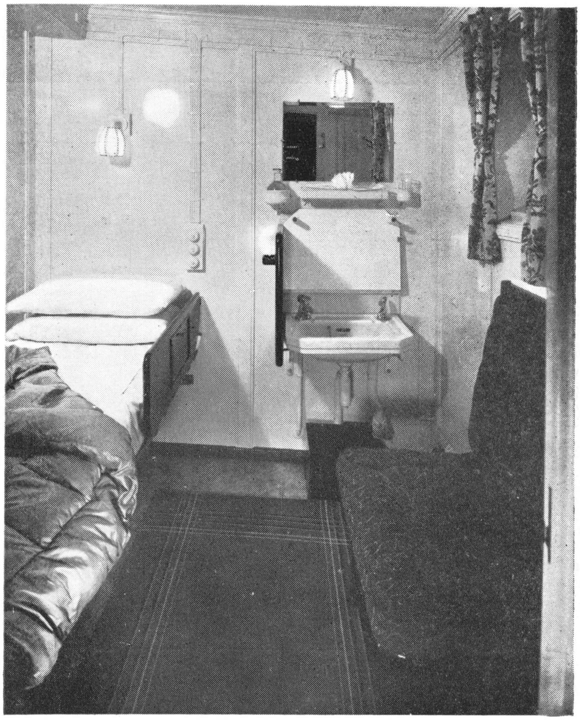
Left : Unusual passenger power—an " L3 " 2-6-4 tank, No. 5340 (since renumbered 9059) with an up empty stock train at Northwood [*B. K. Cooper*]



Right : On the Chesham branch—No. 5115, a 4-4-2 tank of Class " C13 " (since renumbered 7438) on the single track between Chesham and Chalfont [*H. C. Casserley*]

1947 MARITIME PROGRESS OF BRITISH RAILWAYS



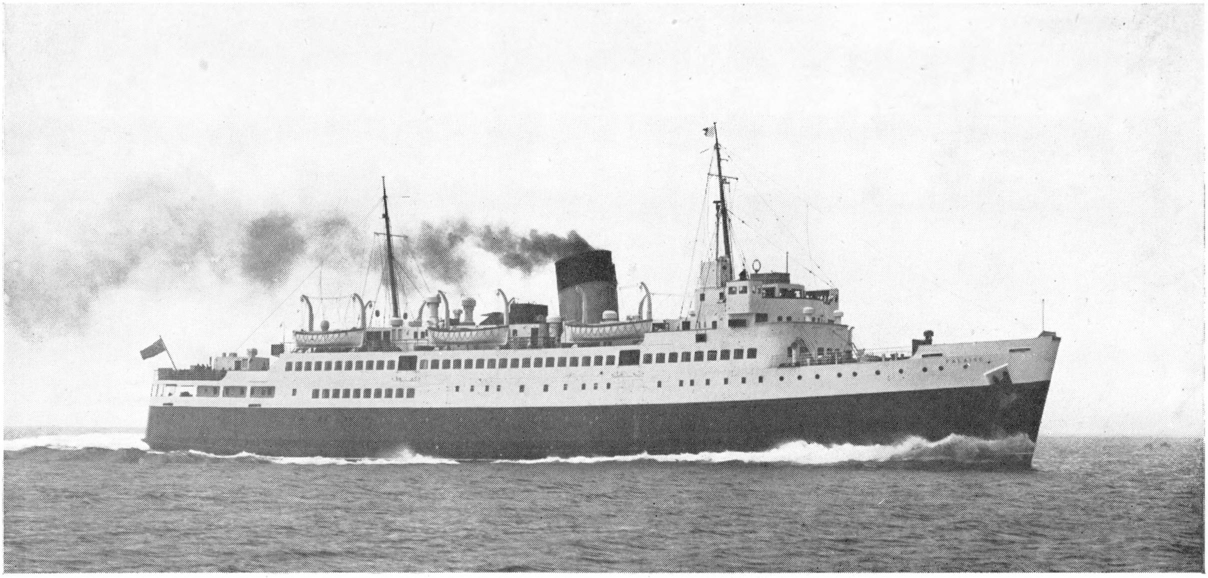


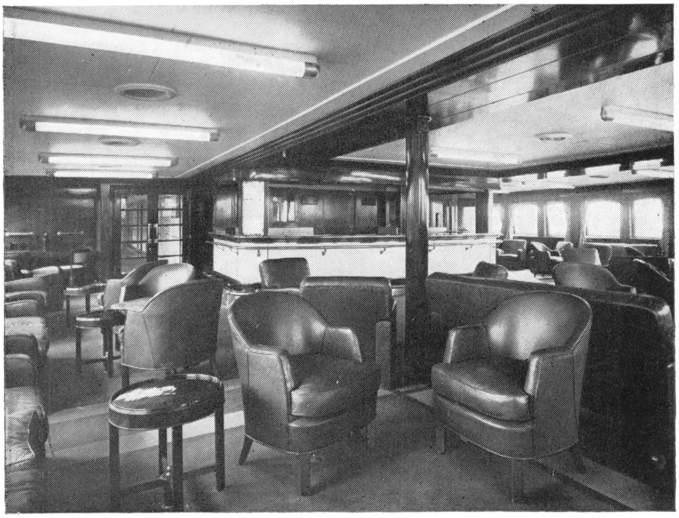
Above : S.S. *Arnhem* of the L.N.E.R., which entered the Harwich-Hook of Holland service in 1947

Middle left : The cosy lounge with its inlaid panel of Dutch designs

Middle right : A single-berth cabin on "A" deck

Bottom right : The attractive entrance to the *Arnhem's* "A" deck





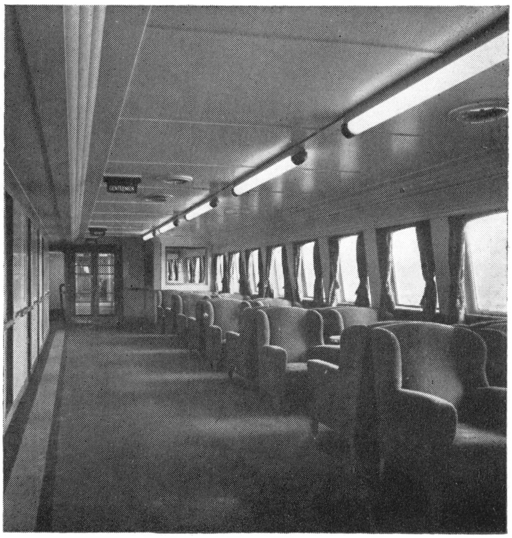
ANOTHER NEW 1947 RAILWAY STEAMER

The S.S. *Falaise*, built for the Southern Railway Cross-Channel services.

Left : The first class smoking room

Lower left : First class restaurant

Lower right : First class lounge on "B" deck



KEEPING U.S.A. TRAFFIC MOVING

By " Alco "

IN recent years the principal railways in the U.S.A. have shown their realisation of the need for a general speeding up of traffic movements, and it is worth while to record some of the methods adopted to achieve this. As might be expected, the entry of the U.S.A. into the war, and the later shortage of labour and materials, retarded appreciably the carrying out of many improvements either already planned, or likely to have been projected. Moreover, not only was there a phenomenal increase of traffic, but on many main lines the direction of its flow was almost completely changed, especially when the European war ended, and every effort had to be concentrated against Japan.

Yet this very increase and altered flow of traffic had the effect of making other improvements essential, particularly on the far-flung western lines leading to the Pacific coast. Furthermore, advances in steam locomotive design, and the increasing use of diesel-electric traction for fast and heavy main-line work, have produced a large stud of motive power units of such capacity and high availability that it has become more than ever necessary to utilise such power to its utmost advantage. Corresponding advances in the control of traffic and in signalling therefore became necessary.

A large proportion of the 250,000 route miles of railway in the United States consists of single-track line. Much of this is unsignalled, and without any form of block working. Where signalling is provided, it consists mainly of semi-automatic and automatic block systems, though manual block working is in force in some areas. Signal indication is afforded mostly by lights—multiple-aspect or searchlight colour-lights, or position lights. Semaphores are no longer installed in new projects, and such installations as exist are gradually being changed to light signals as they fall due for renewal.

Trains are operated by timetable and train orders. Despatchers are located at strategic points to direct movements as required by constantly changing conditions out on the line. These despatchers issue, or cause to be issued at intermediate stations where a telegraph office is open, as may be necessary, what are known as train orders.

These orders, written on specific forms, are issued to regular and special trains and give directions for any shunting movements required, whether for following trains to pass or, in single-track territory, for " meets " to be made with opposing trains. The orders are usually delivered to trains by stopping the trains out of course, and most of the wayside stations are equipped with train order signals, quite distinct from the ordinary signalling. Sometimes train orders are delivered to trains moving at speed.

Copies of these orders are handed to the " engineer " (driver) and " conductor " (guard) of the trains concerned ; the delivering station also files a copy. The rules normally require the engineer to read his orders to his fireman, and the conductor to acquaint the trainmen under him of their contents. Further, train orders are subject to amendment (by the issue of annulment and supplementary orders), on account of variations in the operating conditions on any particular section of line.

Should a train make any out-of-course stop on account of a minor mishap or other cause, and also when making other stops provided for in the rules, the conductor immediately sends one or more of his brakesmen out with flags and fusees to " protect "

the train. This may be head-end or rear-end protection, against either following or opposing trains. The men are recalled to the train by means of the engine whistle when it is ready to proceed.

Such protective operations in fully signalled territory may sound superfluous to our British ears, but they are rendered necessary by the block systems in use in North America. These include a " stop and proceed, expecting to find block occupied " rule, which permits trains to *pass* a danger signal after making a brief stop. On some steeply-graded sections of line, certain specified signals may even be passed at danger on the up grade without stopping, but at a speed not exceeding 8 m.p.h. Such a rule obviously has some advantages, but it can be attended with disastrous consequences if, as occasionally happens, it is loosely interpreted by the enginemen.

In unsignalled territory, and not infrequently where signal protection exists, entrance to passing loops is obtainable only by means of hand-thrown switches. Any train requiring to take such a loop must therefore halt at the entering switch, and wait while one of the train crew throws it over. Similar action must be taken after the train has left the loop to continue its journey, for the switches must be left properly lined up for through running.

Thus on other than fully signalled and interlocked multi-track main lines, the American train is liable to be stopped frequently. The resultant delay, wastage of fuel, lowering of average speed, and undue track occupancy reduce the earning capacity of the particular stretch of line concerned. Further, a freight train of from 50 to 100 bogie wagons, *plus* locomotive and caboose, measures from half to nearly a mile in length. With such trains difficulties arise in the exchange of signals between the enginemen in front and the train crew in rear, particularly when restarting after stops, so causing further loss of time.

Elimination of these frequent stoppages has provided a wide field for improved operating methods. Among such developments, one of the most important has been Centralised Traffic Control, or " C.T.C." for short. This revolutionary principle exchanges the old method of operation by time-table and train orders for movement purely by signal indication.

C.T.C. has been applied mainly to single-track sections of line of varying length, subject to heavy traffic movements, and perhaps containing some adverse operating condition such as severe gradients. Applications have been made also in multi-track territory, where one or more of the tracks may be used at will by trains in either direction, according to the density of the traffic flow. Under C.T.C., one man takes exclusive charge of a section of line, which may range from a few miles in length to an entire division of 150 miles or even more.

On a section of line so equipped, a control point is established at either end, or intermediately, or even at some remote but strategic point on an adjoining division. If the section was previously unsignalled, track circuits are installed and signals erected as and where desired. With rare exceptions, entrances to and exits from loops are protected in this way, and fitted with power-operated switches. Care is needed in arranging signal sites, if the maximum benefit is to be derived from the installation. If the section is provided already with signals, however, these are modernised and respaced if necessary, and track circuits are altered to meet the new conditions.

The control " machine," as it is called, is usually installed in some existing building at the selected point. Generally it consists of a main panel facing the operator, and two

smaller side panels. The size of the panels depends on the length of line over which control is to be exercised. At the top of the panels is a diagram of all trackage in the control area, equipped with lights to indicate where, along its length, main tracks and loops are occupied. In some installations, separate sets of lamps are provided for each direction of movement. Names of intermediate stations are shown, and also the name and wagon capacity of each loop.

Below this diagram there are two rows of miniature levers, somewhat resembling, though on a more delicate scale, the controls of an electric cooker. The upper row of levers governs the switches, and the lower row the signals, every signal or switch along this length of line being worked from the control machine, at no matter what distance away. All levers have tell-tale lights to show whether signals and switches are responding as they should. Start buttons are provided for code controls for switch and signal operation, in the manner described in the next paragraph.

The lower part of the machine consists of the operator's desk. This includes a train diagram for the whole of the route controlled from the machine. On this a set of electrically-operated pens records automatically all train movements, and other data connected with the working of the section. For example, the length of time signals stand at clear prior to the arrival of trains, the trains which pass signals at danger, and so on, are all faithfully recorded. At hand are a telephone, and perhaps also loud speaker equipment, for the operator's use.

Operation of the machine is all-electric, usually from storage batteries fed from a.c. power distribution lines. Switches and signals are worked by coded control circuits imposed on existing lineside wires or track circuits. To send coded controls, switch and signal levers are turned to the desired position and the appropriate start buttons are pressed ; the controls then go out to the lineside locations involved, causing switches and signals to move to the required direction and aspect, and the tell-tale lights on the machine alter to agree with the line-up which has been made. It is amazing to realise that all this work at a station may be done from a control machine that is located perhaps 50 miles or more away.

C.T.C. is expensive to instal, but in addition to speeding up the working, it eliminates many expenses incurred under the old despatching system, affords greater safety and is in every way a paying proposition. The first installation was made in 1927, and by the end of 1941 some 2,700 miles of line had been so treated. Between the beginning of 1942 and the end of 1945, an additional 5,000 miles were equipped similarly, to assist in moving the heavy wartime traffic, and further installations are continually being brought into use. The longest installation controlled from a single machine is between Las Vegas, Nevada, and Yermo, California (171 miles) on the single-track main line of the Union Pacific Railroad, a distance slightly longer than from Inverness to Wick, or from Glasgow to Mallaig, to give it a homely comparison.

From what has already been written, the need for and the advantages of some form of communication with trains is obvious. With the growth of electrical and radio developments, this communication problem has come within the range of practical politics. The first experiment in this direction is said to have been made as far back as 1885, but it is only within the past decade or so that general attention has been directed to the subject. Success has attended the investigations which have been undertaken and matters are now passing from the experimental stage to that of application.

For a communication system completely to fulfil its intended function, it must provide for three primary needs, namely, to make communication possible between:

1. The head and rear ends of the same train;
2. The head and rear ends of a train and selected wayside points, i.e., stations and yards;
3. Two or more locomotives or trains moving simultaneously within the area of any particular installation.

In the United States two main systems have been adopted in various ways—carrier induction and radio. While both have given satisfactory communication between the head and rear ends of the same train, good results between train and wayside points and between train and train appear to be available over a greater range of distance with the carrier induction system than with radio.

Carrier induction equipment operates at a frequency of about 170 kilocycles, using existing lineside wires to carry the train communication energy. Transmitting and receiving apparatus with loudspeaker and hand telephone sets is fitted to locomotives and cabooses, and also at the selected wayside points. The apparatus on the locomotives and the cabooses is mounted in such a way as to be safeguarded against shocks.

When transmitting from a locomotive, power at 170 kilocycles is applied to the antenna to create a magnetic field which links up with the lineside wires and induces in them the same 170 kilocycle energy. A 50-watt output will enable this to be picked up by the caboose at the rear of the train or by selected wayside points up to a distance of 50-60 miles. In communicating from train to train the range is much shortened, owing to loss of power by the double gap to be bridged inductively. Transmission from a lineside point to a train, however, requires a lower power output, for one induction gap only is involved.

At all points, whether moving or stationary, the apparatus normally stands in "receiving" position connected to the loudspeaker; the latter is used in its calling capacity alone. When an incoming call is heard, the person addressed at once removes his hand-set from its hook switch, automatically cutting the loudspeaker out and the hand-set in, and so enabling the message to be received. When the addressee in his turn wishes to speak, he presses a button on his hand-set, so cutting out the receiver and bringing the transmitter into operation. To minimise confusion, the volume controls on the locomotive and caboose loudspeakers are adjusted so as to receive calls only from the nearest of the lineside transmitters.

In the case of communication made by radio, high-frequency transmitting and receiving equipment, generally operating in the 156-162 megacycles range, is applied to locomotives and cabooses, and at the wayside points. The design of antennae is usually more complicated, and a good deal of care is needed in the selection of sites for aerials. Special wave-lengths have been allotted to the railways by the Federal authorities. While radio communication systems have given every satisfaction in yard service, there seems to be scope for further developments and tests in regard to their application to road service. In certain conditions and locations, particularly in very deep cuttings and tunnels, occasional "blind-spots" have been encountered, and also a very reduced range of effectiveness. No doubt further attention will be devoted to these problems until the difficulties have been overcome.

Bearing in mind the normal methods of train operation in the U.S.A., what are the

uses of train communication as applied to the actual movement of traffic ? Well, inter-train communication enables enginemen and conductor to compare train orders whilst running, expedites the giving of " right-away " signals and making brake tests, supplements hand signals when conditions of visibility or the location of a train renders them uncertain or impossible (on a sharp curve in a cutting, for example), and obviates all kinds of other difficulties and delays caused by the enormous length of American freight trains. Immediate notice can also be given and action taken if the men at either end of the train observe anything out of order on any vehicle in it.

Communication between wayside points and trains affords similar opportunities for stations to notify trains of anything seen to be amiss while the train is passing, or of sudden changes of train orders. It is also possible to advise a train crew that a faster-timed train behind is running late, so enabling the slower train to continue along the main line beyond the point at which normally it would take the siding for the express to pass. From the other side, trains can notify the despatcher of delays that they have encountered, and why, or if they need an assisting locomotive because of engine trouble. This kind of communication is equally useful in yard service, so much so that in some tests it has been established that trains can be either broken up or put together in two-thirds of the time that would have been required in previous conditions.

In just the same way inter-train communication enables one train to notify the crew of another if they have noticed anything out of order. Train crews can warn one another, too, of anything wrong with the track, or of other unusual conditions likely to endanger train running. Above all, however, it enables instant notice to be given to all trains in the vicinity should a train have to make an emergency stop, thus affording an invaluable addition to any flag protection which would normally be made.

As an example of what can be achieved, some figures of a test on the Chicago and North Western Railway, described in the *Railway Age*, are of considerable interest. A diesel-hauled freight train of 108 cars (5,300 tons) ran from the Proviso Yard, Chicago, to Council Bluffs, Iowa, 486 miles, in 22 hours 45 minutes. In addition to the usual exchange of signals between the head and rear ends of the train, two train defects were noted and reported, one of which necessitated detaching the defective vehicle, and a dangerously shifted load was reported to the train crew by a wayside station. At one point the late running of a following passenger train was notified, so enabling the test train to continue running for another 18 miles before shunting for overtaking purposes. In all, it was estimated that the frequent use of the train telephone resulted in a saving of not less than 2½ hours. In this particular test, the system of communication in use was high-frequency radio.

Many other devices and methods are used in the U.S.A. to help in assuring safety in these days of ever-increasing speed. For example, there is cab-signalling, operated by various methods, which gives continuous colour-light indication in the engine cab of conditions ahead, and is not merely a warning device. To assist in operation, there is either-direction signalling of one or more tracks in multi-track territory, enabling trains to be run against the normal current of traffic when necessary. Then there are spring switches with automatic facing-point lock protection at the ends of passing loops, or where double track gives place to single track, thereby eliminating train stops for switching from one track to another. Lastly, there has been mechanisation on an extensive scale of marshalling yards. Much might be written on these, but must wait for another time.

RAILWAYS "DOWN UNDER"

By " Quicksilver "

IN the heart of the Continent of Australia there lies a plain covering a total area of some 100,000 miles. Its limestone formation, in the prehistoric past, was laid down under water, and then, by some great upheaval, raised to become dry land. Into its cavities and blowholes such water as falls in this great desert soaks like a sponge. By day the sun shines in a heaven of cloudless blue, and beneath it sleeps the earth, unbroken by hill or valley, by tree or house, or by any of the accustomed sights of civilisation ; at night, under the moon, the bluish-white and grey-green of the stunted vegetation looks even more ghostly than by day.

Across the desert waste of the Nullarbor Plain there runs a railway, and from the windows of its trains passengers look out on this desolate scene for a full 450 miles. The very name " Nullarbor," derived from the Latin, means " no trees." Across the plain no less than 328 miles of the line are dead straight—the longest straight of any railway in the world. The railway is the property of the Commonwealth of Australia, for no individual state could have afforded to lay down and to work the 1,108 miles of line between Kalgoorlie and Port Pirie, linking up Western Australia with South Australia, through such totally unproductive country.

Midway on the run, at Cook, there is a lonely locomotive depot, 538 miles from Kalgoorlie and 570 miles from Port Pirie, where locomotives are changed. Each of the two locomotives needed for the through journey is at work for 14 to 15 hours, for the entire run takes some 30 hours ; and until the new 12,000-gallon tenders were introduced, special additional water tank cars had to be attached behind the engine tenders, for in such waterless country there is little possibility of taking any water *en route*. Even the important town of Kalgoorlie has to have its water piped from over 350 miles away. Stops are made at tiny settlements, spaced widely apart and chiefly inhabited by the men who look after the track ; here ragged aboriginals from their primitive encampments come to the trains to beg from the passengers. It is the loneliest railway ride on earth.

Inside the train, however, the passengers, even if bored by the monotony of the scenery, travel in complete comfort, with sleeping cars for the two nights spent in the train, a dining car, and a lounge car, unique in its possession of a piano, to help the passengers in beguiling the long and weary hours. Incidentally, the travel charge compulsorily includes meals and sleeping berths ; what is more, the passenger who fails to book his place on the train probably will not travel, for advance reservation must be made.

Yet such are the amazing contrasts of Australia that at no more than 900 miles from the eastern confines of the Nullarbor Plain the traveller finds himself in Flinders Street Station at Melbourne, which claims to be the busiest in the world, and on one single day has counted no fewer than 317,322 passengers passing through its barriers.

The Trans-Australian Railway has been built by the Commonwealth Government to connect the railways of Western Australia with those of the southern and eastern states of Australia. One day, when the long gap has been bridged between the line coming southwards from Port Darwin, and the narrow gauge line which makes its way north-

wards for 961 miles from Adelaide to the farming centre of Alice Springs, in the heart of Central Australia, it will be possible to travel by rail from extreme north to extreme south as well. But as things are, no journey in one through coach will be possible.

For the great railway handicap of Australia is the fact that each state, when laying its first railways, chose the gauge which it thought would best meet its own needs, without regard to what the adjacent states were doing. As a result, while Western Australia and Queensland were laying out their railway systems on the 3 ft. 6 in. gauge, and New South Wales had decided on the general world standard of 4 ft. 8½ in., Victoria and South Australia decided to go one better, and have a wide gauge of 5 ft. 3 in. For the Trans-Australian line, the Commonwealth Government fixed on 4 ft. 8½ in.

Let us see, now, how this gauge problem affects a journey between, say, the cities of Perth and Brisbane, capitals respectively of Western Australia and Queensland, just over 3,300 miles apart. At Perth the passenger gets into his 3 ft. 6 in. gauge train of the Western Australian Government Railways for an overnight journey of 375 miles to Kalgoorlie. At the great gold-mining centre, he must change into the 4 ft. 8½ in. gauge transcontinental train in which he is going to spend two nights and a day.

In earlier days, the Trans-Australian train went no further than Port Augusta, and a stretch of 3 ft. 6 in. gauge line through Terowie necessitated a double change before Adelaide, capital of South Australia, was reached. But the Commonwealth Government later extended its line over the 57 miles from Port Augusta to Port Pirie Junction, so that to-day the passenger can step straight from the train which has brought him from Kalgoorlie into the 5 ft. 3 in. gauge express of the South Australian Railways which is to carry him on to Adelaide. Here, 1,617 miles of the journey have been completed.

South Australia and Victoria are the only two adjacent states in the Commonwealth that enjoy the same gauge—5 ft. 3 in. So, starting from the fine main station at Adelaide, where through coaches from Port Pirie are attached, the "Overland Express" runs right through over both the South Australian and Victorian Railways into Flinders Street Station at Melbourne, 483 miles away. Not so with the "Spirit of Progress" between Melbourne and Sydney, however, for the New South Wales gauge is 4 ft. 8½ in., and the passenger is thus compelled to turn out at the frontier station of Albury. In earlier days there had to be a similar change from the New South Wales gauge to the 3 ft. 6 in. of Queensland, but to avoid this last break, some years ago a standard gauge line was run from Casino for 113 miles through Kyogle to the Richmond Gap, on the frontier, and from there direct into South Brisbane.

Originally, therefore, the passenger from Perth to Brisbane passed in succession over six different gauges—3 ft. 6 in., 4 ft. 8½ in., 3 ft. 6 in., 5 ft. 3 in. (through two states), 4 ft. 8½ in., and 3 ft. 6 in. again ; now the succession has come down to four—3 ft. 6 in., 4 ft. 8½ in., 5 ft. 3 in., and 4 ft. 8½ in. The handling of freight is considerably more troublesome than that of the passenger, who can change trains by the use of his own legs, whereas at every one of these breaks of gauge, all through freight must be transhipped from one wagon to another—a costly business. Notwithstanding the heavy expense involved in conversion, there are prospects of improvement at least by laying standard 4 ft. 8½ in. gauge between the New South Wales frontier and Melbourne, which would permit through running between three of the state capitals—Brisbane, Sydney, and Melbourne.

In recent years considerable progress has been made in speed over the principal Australian main lines, despite the difficulties of gradients which, on certain sections,

are very severe. Over the Victorian Railways, the famous "Spirit of Progress", which normally makes no stop between the New South Wales border and Melbourne, runs the 190¾ miles from Albury into Melbourne in 215 minutes, non-stop, at 53.3 m.p.h., except on Sundays, when five intermediate stops are squeezed into the schedule, but the same overall time must be maintained. A remarkable run is that of the "Caves Express" of the New South Wales Railways, which serves the tourist resorts in the Blue Mountains; the engine of this express has a gruelling task, for in the 32¾ miles from Emu Plains to Katoomba the line climbs 3,245 ft. Although six intermediate stops are made, the train gets up to Katoomba, 68¼ miles from Sydney, in 1 hour 55 minutes from the start.

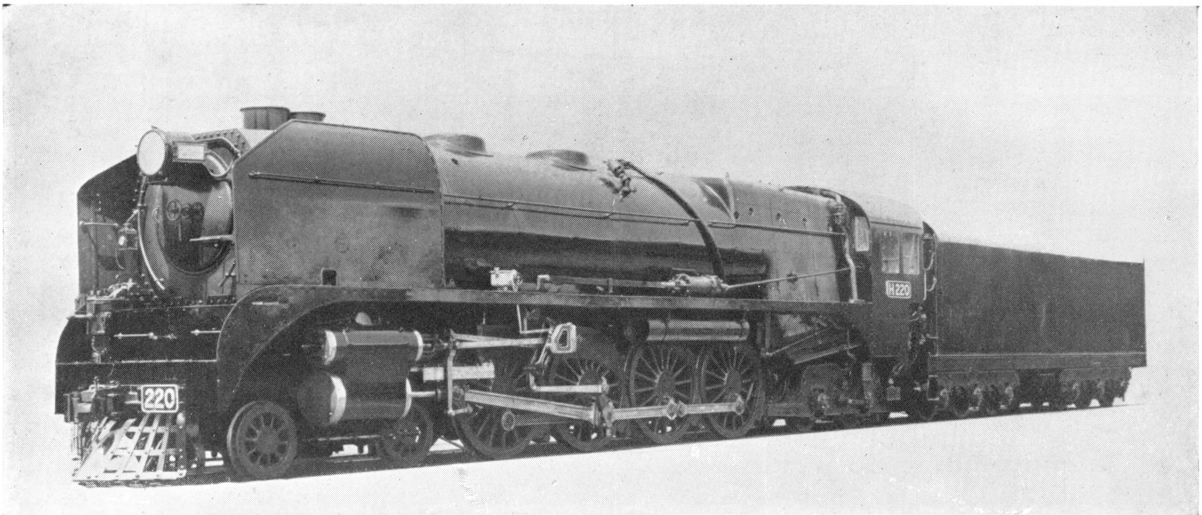
Some very large and powerful locomotives are appearing on Australian tracks, especially those of the New South Wales, Victorian and South Australian railways, which have heavy gradients to surmount on their principal main lines. Pacific and 4-8-4 locomotives are used for the principal express trains, and 2-8-2, 4-8-2 and 4-8-4 locomotives are being introduced for heavy freight haulage.

The huge " H " class 4-8-4 engines of the Victorian Railways, for example, turn the scale with their tenders at 260 tons—nearly 100 tons more than a British Pacific—and for the first time in Australian practice they make use of mechanical stoking. They have 21½ in. by 28 in. cylinders, 5 ft. 6 in. driving wheels, 4,880 sq. ft. of combined heating surface, 68 sq. ft. of firegrate area, 220 lb. pressure, and a tractive effort of 55,000 lb. Their tenders, accommodating 14,000 gallons of water and 9 tons of coal, are carried on twelve wheels and alone weigh 113½ tons. They are designed to haul the 550-ton "Overland Express" up the Ingliston bank, between Melbourne and Ballarat, without taking assistance on the 1 in 48 gradient. The latest 4-8-4 engines in South Australia and New South Wales also weigh 233 and 228 tons respectively.

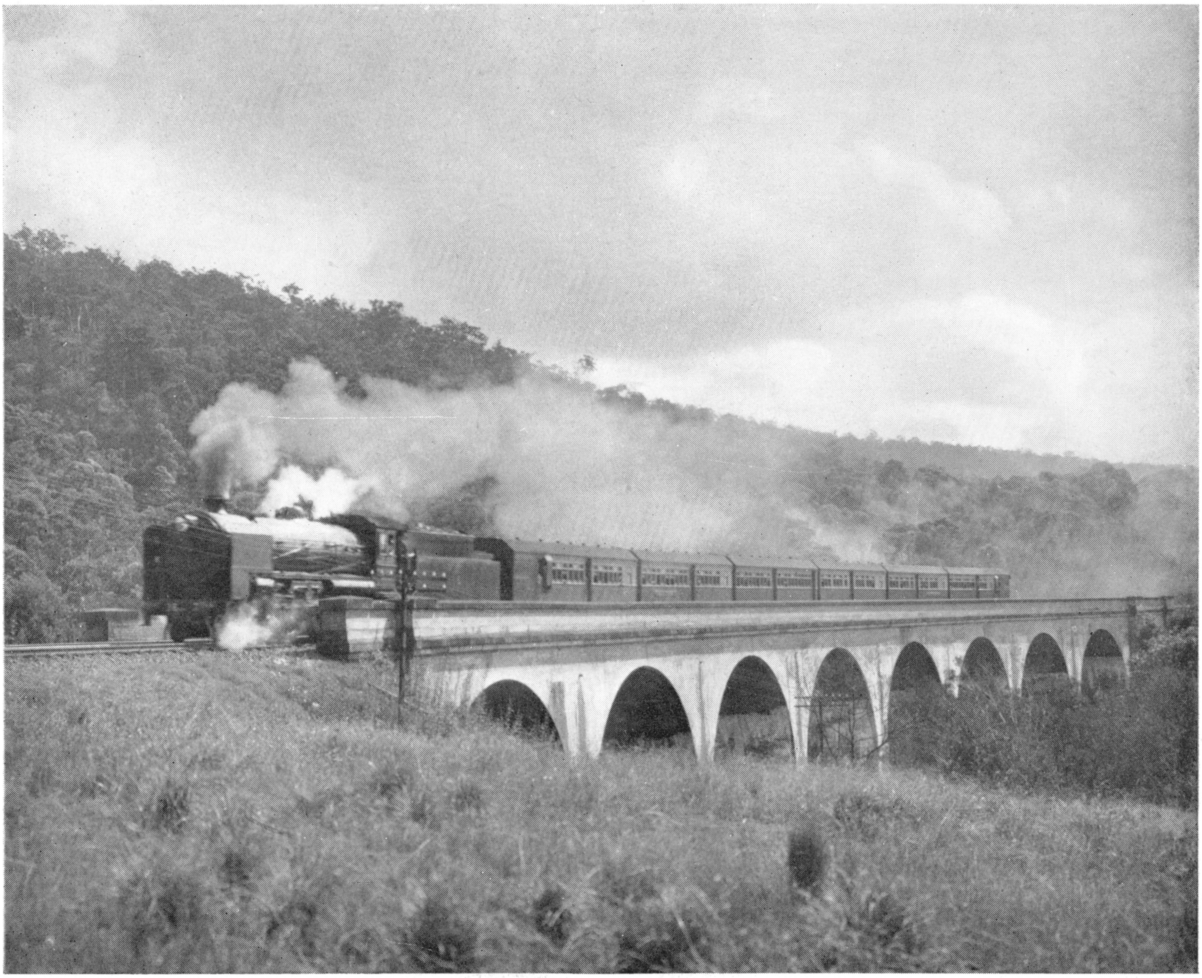
Railway electrification in Australia is confined chiefly to the great cities of Sydney and Melbourne, the former with a population of 1,240,000—the third largest city in the British Empire—and the latter with 975,200. As previously mentioned, it is in Flinders Street Station at Melbourne that the chief passenger records are made. Between Flinders Street and Spencer Street stations, at the rush hours, up to 52 trains every hour pass over the connecting viaduct, which carries a double line only. From Flinders Street there radiate 173 route miles of electrified track, or 439 single track miles; the longest of these is to Port Phillips Bay, 26½ miles out of the city. For passenger service 850 cars are needed; the normal multiple-unit trains are seven cars long.

Dealing with traffic at Flinders Street is facilitated because all its 16 platforms are of the through and not the terminal type. In 24 hours, Flinders Street handles up to 2,070 electric and 150 steam trains; the maximum frequency in a single hour is 158 trains. The electric trains use 1,500-volt direct current; producing the current takes 150,000 tons of coal annually, and the electric cars travel 30,000,000 car-miles every year.

In the engineering realm, Australia may well be proud of the possession of what, on many counts, is the most outstanding bridge structure in the world. This, of course, is Sydney Harbour Bridge, in New South Wales, with its 1,650 ft. span carrying four railway tracks, a 57-ft. roadway, and two 10-ft. footways. It is of British interest, too, seeing that the designers and builders of the bridge were the British firm of Dorman, Long & Co., who carried the work successfully to completion, notwithstanding the claims of prominent American and German engineers that erection of such a design, in view of the formidable difficulties involved, would be impossible.



BIGGEST IN AUSTRALIA
One of the Victorian Government Railways 260-ton 5 ft. 3 in. gauge " H " class 4-8-4 engines, with 12-wheel tender



ON ITS 3,245-FT. CLIMB INTO THE BLUE MOUNTAINS—The " Caves Express," New South Wales Government Railways, on Lapstone Viaduct, hauled by a class " C36 " Pacific (Gauge 4 ft. 8½ in.)


RF
POSTES
1F50
PARIS 1937
13e CONGRES INTERNATIONAL DES CHEMINS DE FER
5 MILLS
EGYPTE
1852
CONGRES INTERNATIONAL DES CHEMINS DE FER-1933
ЦАРСТВО БЪЛГАРИЯ
1938
ЛВ. 1
A MAGYAR VASUT
20.000 ap
100 ÉVES
1846-1946
MAGYAR POSTA
FRANCE
1F50
POSTES
CRÉATION DU SERVICE AMBULANT. 1844
12
ÖSTERREICH
REPUBLICA DEL PARAGUAY
CORREOS
1861-LOCOMOTORA DEL PRIMER FERROCARRIL PARAGUAYO-1861
5 CENTIMOS 5
REPUBLICA ORIENTAL DEL URUGUAY
5 CENTESIMOS 5
NEDERLAND
100 JAAR NEDERLANDSCHE SPOORWEGEN
1839
1939
5 CENT 5
6
1835 - 1935
100 Jahre Deutsche Eisenbahn
6
Deutsches Reich
PERÚ
SERVICIO
AEREO
LA CALLAO DEL 1er FERROCARRIL EN SUD-AMERICA. 1851
35 CTS.
CORREOS
PRIMER CENTENARIO POLITICO DE LA PROVINCIA DEL CALLAO
1836 - 1936
35 CTS.
WATERLOW & SONS LIMITED, LONDRES.
1 RL.
POSTES PERSANES
CORREOS DEL PERU
SERVICIO AÉREO
1 SOL
FERROCARRIL CENTRAL DEL PERU. EL MAS ALTO DEL MUNDO DE ENTRE-VIA NORMAL. (LA CIMA A 4.817.60 M.)
WATERLOW & SONS LIMITED, LONDRES.
RF
POSTES
30c
PARIS 1937
13me CONGRES INTERNATIONAL DES CHEMINS DE FER
METPO
15 КОП
СССР ПОЧТА
ROMANIA
AL XVI CONGRES
POSTA
LEI
10+490
ASOCIATIA GENERALA A INGINERILOR DIN ROMANIA

RAILWAYS ON STAMPS

By Kathleen M. Casserley

ONE of the many " branch lines " to which the railway enthusiast may direct his attention is the making of a collection of the various postage stamps of the world that depict subjects of railway interest. At first sight there may not appear to be much in common between philately and a study of railways, and if every country maintained the same uninspired attitude in the production of its postage stamps as the British Post Office throughout its history, this would indeed be the case. Most other countries in the world, however, including our own Dominions and Colonies, have long since realised the value, both as publicity and for financial reasons, of issuing interesting pictorial stamps. The sale of such stamps to collectors all over the world can make a very substantial addition to national revenue.

Thus a representative collection of the world's stamps depicts quite a wide variety of scenes of every conceivable description, many of which are real works of art in miniature. Amongst this vast array, not unnaturally, are many railway subjects. They include pictures of locomotives, old and new, trains, railway bridges, scenes which include lines of railway, and so on, and it is with these that we are now concerned. Certain countries are particularly " railway minded " in this connection, notably the United States and some of the South American Republics.

The first stamp to picture a railway subject was one issued by the State of New Brunswick (which now uses the general Canadian issue of stamps) in 1860, showing an early 4-4-0 of the period. The second was in the U.S.A. in 1869 ; and after that locomotives and trains began to be featured on the stamps of many different countries. During recent years particularly the issue of railway stamps has increased greatly in connection with the various centenaries of the first railways in many lands, which have been celebrated with a commemorative stamp issue. In some cases these depict the first locomotive on one value and the newest on others, as in the case of the German set of 1935, the Austrian set of 1937, the Italian and Dutch sets of 1939, and a new Swiss set of 1947.

In all, it is possible to make a collection of over 250 railway stamps that are " face-different " (that is, distinct designs, ignoring more than one of each set where the same scene is used for more than one value of the issue), but to do this nowadays would prove an extremely difficult and expensive task. Many of these stamps are almost impossible to obtain, and others have increased enormously over their original cost owing to their comparative scarcity and the demand so created.

One of the most attractive railway sets ever issued was a set of four by Egypt in 1933, showing respectively two 2-2-2 locomotives, a 2-4-0, and a handsome Atlantic, at that time Egypt's largest locomotive. All these engines were British-built ; of the 2-2-2s, one, of typically Caledonian outline, commemorates the fact that in 1862, three single-drivers of Benjamin Connor's design, built by Neilson & Company in Glasgow, were sent out to Egypt. This set, which could be obtained for a shilling or two when first issued, cannot be bought to-day for less than £3.

The only English locomotive ever to appear on a stamp issue was not on a British stamp, it need hardly be said, but on an issue by Uruguay in 1895, in which an unmistakable G.N.R. Stirling 8 ft. single is clearly shown. What connection the old G.N.R. or Patrick Stirling had with Uruguay has never been established ; the explanation may lie in the fact that the stamps were printed in this country by Waterlow, and that the printers were asked to depict a locomotive of some sort. They may have happened to have had an illustration of one of these engines suitable for making the engraving, but this is conjecture only. The stamp is fairly well known, and may be found in three different colours, green, red, and blue.

Amongst the rarest issues of railway stamps are four sets of five each issued by Nicaragua in 1933 to commemorate the opening of the Rivas and Léon-Sauce Railways, but these are very poor and crude productions and not worth the attention of any but the specialised collector endeavouring to attain completeness. It is said that only a thousand sets were issued, and with such a small number printed these stamps would command a far higher price than they do had they been made more attractive and were at all sought after.

On page 50 a number of foreign stamps of typical railway interest are reproduced, though unfortunately without the colours that play so important a part in their appearance. In the centre of the top row is the 2-4-0 locomotive from the set issued in Egypt for the International Railway Congress at Cairo in 1933. To the left is a modern French streamlined express engine, on one of a set of two issued for a later Congress of the same organisation at Paris in 1937 ; the other stamp in the series is an electric locomotive shown in the bottom left-hand corner of the page. On the top right-hand side is an early Bulgarian engine, one of a set printed for the Jubilee of the Bulgarian State Railways in 1938. It is of interest to recall that both the late King Boris, who was reigning at the time, and his father, King Ferdinand, who abdicated in 1918, were railway enthusiasts, and had had some practice even in driving engines! The top value actually shows King Boris on the footplate. Below the Bulgarian stamps is one of the Austrian Centenary set of 1937, showing one of Austria's first locomotives with what looks like the spire of St. Stephen's Cathedral, Vienna, in the background.

In the centre of the second row is a very interesting stamp showing one of the earliest French postal vans. Let us hope that the comfort and convenience of the interior equalled the ornamentation of the exterior ! This stamp was issued during the German occupation, for even the Nazis recognised the importance of this type of stamp, and never missed an opportunity for a commemorative issue. Next to it is a stamp from a lovely Hungarian set issued as recently as 1946. Note the value of the stamp—it was issued during the collapse of Hungary's former currency.

Four interesting old locomotives are shown in the centre row of the page. On the left is a stamp issued by Paraguay in 1944, depicting a very old 4-2-2 tank engine, on which can be seen the number " F.C.R. No. 10." Next to it is the picture of the British Stirling single issed by Uruguay, already mentioned ; although the engine undoubtedly is a British type, the passengers and the scenery are typically South American. Altogether, therefore, this is a philatelic problem-picture. Holland's first engine is next illustrated, this stamp being one of a pair issued for her railway centenary, while this row of veterans is completed by Germany's first locomotive, one of a set of four ranging from ancient to modern, issued in 1935 for the same reason.

Two Peruvian locomotives are shown on the next line ; these stamps were issued in 1936. The first is *La Callao*, an old 4-4-0, while the right-hand picture shows a train at La Cima, the highest standard gauge railway summit in the world, 15,806 ft. above sea level, on a branch of the Peruvian Central Railway in the Andes. The only higher summit is one of 15,817 ft. on the Callahuassi branch of the Autofagasta (Chile) & Bolivia metre-gauge railway, not very far away. Persia gives us a handsome view of a locomotive crossing a bridge over the River Keroun, a tributary of the famous Euphrates, and the stamp in question is illustrated in the centre of the fourth row.

At the bottom of the page appears a view of Moscow's Underground, which in certain respects is as up to date as that of London ; and a stamp showing part of a Roumanian electric railway with overhead transmission, similar to that installed by the L.B.S.C.R. in South London, and now being adopted also by the L.N.E.R. in its Liverpool Street-Shenfield and Sheffield-Manchester electrification schemes. These illustrations give some idea of the variety which a railway enthusiast can find in the collection of stamps which have a direct bearing on his hobby.

As a " railway " beginning, collectors might aim at trying to acquire the following issues, several of which have just been mentioned among the illustrations in this article :

The Belgian parcel set of 1935.
The South West Africa 1½d. value.
The striking Hungarian set of 1946.
The Swiss Railway Centenary sets of 1947.
The 4d. value of the New Zealand Centennial set of 1940.
The Metro sets of Russia, showing scenes on Moscow's tube.
The Bulgarian Jubilee set of 1938, with four pictures of old and new locomotives.
The United States parcel stamps of 1912, showing the working of a mail train and other methods of mail transport.
The Peru 1871, 1925, 1927 and 1928 issues, also the two values of the 1936 set which are included among the illustrations.
The Southern Rhodesian Coronation set of 1937, showing a train passing the Victoria Falls, in four beautiful bi-coloured values.

It is a pity that the Swiss Railway Centenary set of 1947 was not available quite in time for reproduction among the illustrations. It includes a representation of Switzerland's first steam locomotive, which worked special trains under its own steam during the recent celebrations, a modern Swiss steam locomotive, and two electric trains.

The collector will derive much pleasure in attempting to compile a list by a careful and systematic study of the stamp catalogue. It is not possible to do this completely, however, without some knowledge of stamps generally, and without the opportunity of examining some fairly comprehensive collections, for not all the stamps available can be discovered merely from the illustrations or descriptions in stamp catalogues.

There are other stamps in which the railway *motif* is present but less obvious. Many philatelists, probably, have handled hundreds of the common Chinese " junk " design without noticing the train on the bridge in the background, and how many have spotted the train shown on the Canadian 20 cent red of 1930 ? Even when one knows it is there, the train is sometimes hard to find between the grain elevators in the background of the stamp ; it needs a good magnifying glass.

Among further stamps which have a certain railway interest are the following:

Transvaal 1895.

Madagascar 1908 set.

Abyssinia 1931, train on viaduct.

Guatemala 1897 set and 1919 30 cents.

Salvador 2 cent brown 1935 (by ship in background).

Chinese stamps, 2 cents of 1936, and the set of 1941.

Many of the Saar stamps showing industrial sidings, and several of the Panama Canal Zone stamps of 1939.

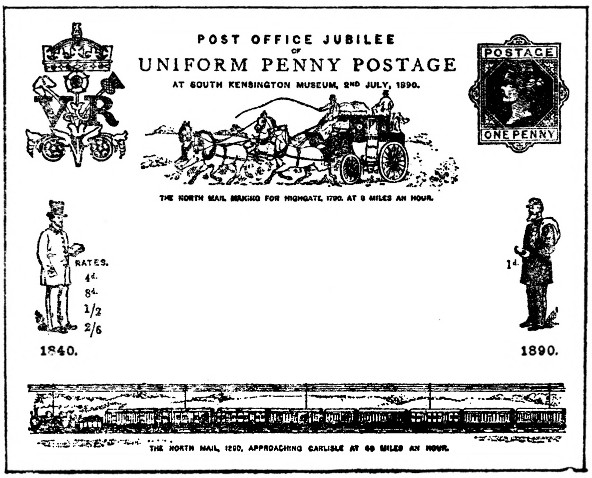
Greek Corinth Canal stamp of 1927, probably handled by hundreds of people who have never noticed the train crossing the viaduct.

Armenia 1922 10k on 2000r red, showing a railway vehicle of some sort on some sidings in front of Mount Ararat! Or is this the Ark being transported by rail from its original resting-place?

There are even sets of stamps overprinted with a locomotive. One is the Ecuador set of 1926, commemorating the opening of the railway between Esmaraldas and Quito. A similar plan was adopted by Cuba for its railway centenary in 1937.

Whilst many countries nowadays issue far too many stamps and only for revenue purposes—Russia, France, Belgium, and many of the South American countries are the worst offenders in this respect—it is a great pity that Great Britain, which produced the first postage stamp, goes so far to the other extreme, and changes its designs so rarely. Real pictorial issues during the whole period of 107 years, and even those with any pretence at pictorial design, can still be counted on the fingers of one hand.

So far as railways are concerned, the nearest that Britain ever got in this direction was a special envelope issued in 1890 to commemorate the Jubilee of penny postage. The illustration below shows a printed Queen's Head penny stamp in the usual place, while at the foot of the envelope appears quite a creditable picture of a mail train of the period, headed by a Webb compound of the L.N.W.R. Unfortunately the day still seems remote when one of our British stamps will be graced with a picture of the 8.30 Night Postal from Euston picking up mailbags at full speed!



L.M.S. LOCOMOTIVE HISTORY

A Brief Review

By H. C. Casserley

AT the great amalgamation of 1923 the newly-formed London Midland and Scottish Railway found itself the possessor of a stud of 10,316 locomotives, of no fewer than 393 different classes. One of its first tasks was to set about eliminating many of the older and less numerous designs and to endeavour to establish some measure of standardisation. The degree to which this end has been attained is measured by the fact that to-day, of the total locomotive stock, now reduced to something like 8,000 engines owing to the more intensive working and greater mileage put in by each locomotive, nearly one-half of the number is divided amongst but nine different standard classes. Construction during the war years and those immediately preceding has been confined exclusively to the multiplication of these classes, with the result that no new designs were brought out between 1937, when the "Coronation" and "Duchess" Pacifics appeared, and the end of 1946, which saw the birth of two new classes, the light 2-6-0's of the "6400" type and the light 2-6-2 tanks of the "1200" series. A new Mogul design, in power class "4F," is under construction, and nearing completion.

Mr. George Hughes was the first C.M.E. of the L.M.S.R., a position he had held on the former Lancashire and Yorkshire Railway, and his first engines for the new company were superheated editions of his 4-cylinder 4-6-0 design which had been in use on the L. & Y.R. for some years. This was the most powerful class of express passenger engine inherited from any of the constituent companies of the L.M.S., and for a time some of them worked the West Coast expresses between Crewe and Carlisle. The design was not an outstanding success, and most of them have now been scrapped, the few survivors being found in the Blackpool area. Ten 4-cylinder 4-6-4 tank engines, which in effect were tank versions of the same class, appeared in 1924, Nos. 11110-11119, but these, too, were found sluggish and heavy on coal, and the last one was scrapped in 1942.

Hughes' most successful design was his 2-6-0 mixed traffic class. Actually the first of these was not built until 1926, after his retirement, but although incorporating certain Midland features and turned out during Fowler's *regime* the design undoubtedly originated from Horwich. Two hundred and forty-five of these engines were built (now Nos. 2700-2944). They are noteworthy in being the first engines on the L.M.S.R. to be fitted with long-travel valve-motion, the value of which was discovered so many years before by Churchward on the G.W.R., but the merits of which it took other companies so long to appreciate. This long-travel, long-lap gear, which with suitable blast-pipe arrangement forms an essential part of modern front-end design, has now become practically universal for new L.M.S. designs except shunting engines, and has resulted in almost as great an improvement in efficiency as did the general introduction of the superheater.

In 1925, Sir Henry Fowler of the Midland assumed control of the locomotive department, and the next few years saw the multiplication of former Midland designs on a large scale. The L.M.S.R. at this time went very closely into the comparative

costs of its principal classes of locomotive, from a constructional, maintenance, and running point of view, and particularly with regard to coal consumption. On these bases the M.R. designs were found to give by far the best figures, and so were adopted temporarily as standard for the whole line. This was all right as far as it went, but the snag was that the Midland had always favoured a policy of employing moderately-sized engines, used in pairs when loads demanded it (as they very often did), rather than the construction of large machines capable of tackling big trains single-handed. Consequently there was no design of large passenger engine capable of working the trains on the main line of the former L.N.W.R., which were usually heavier than those on the Midland line, and something better than the never-too-very-successful 4-cylinder "Claughton" 4-6-0's of the L.N.W.R. was becoming an urgent necessity.

In 1926, therefore, after designs had been hastily prepared, with some assistance from the drawings of the S.R. "Lord Nelson" 4-6-0's, which were loaned by Ashford for the purpose, fifty 3-cylinder 4-6-0's were ordered from the North British Locomotive Company ; by the summer of 1927, a year after the decision to build was reached, the first were placed in service. These were, of course, the well-known "Royal Scot" 3-cylinder 4-6-0 class. Twenty more were built in 1930 at Derby, and this stud of engines has since borne the brunt of the Western Division main line workings, only latterly being relieved, on some of the heaviest turns, by the limited number of Pacifics. With little doubt a considerable influence was exerted on this design by the brilliant performances of the G.W.R. *Launceston Castle* on L.M.S. metals in 1926. Some of the earlier "Royal Scots" at first were given grand old names perpetuated from early engines, such as *Jenny Lind*, *Lady of the Lake*, and *Sanspareil*, and a brass plaque bearing an etched outline of the original engine was carried on the splasher beneath the nameplate. Unhappily these have since been removed and replaced by regimental names.

An experimental 3-cylinder compound engine of this class was built in 1930 with a boiler pressed to no less than 900 lb. per square inch, No. 6399, *Fury*. It was not a success, and was later rebuilt as a simple engine with a Stanier taper boiler, and became No. 6170, *British Legion*. This was the first "Royal Scot" to be fitted with a taper boiler, and the result was so successful that the whole of the "Royal Scots" are now gradually being reboilered similarly, with the addition of a double blast-pipe and a double chimney. The "5XP" 4-6-0's of the "Patriot" and "Jubilee" types, mentioned later, are to be rebuilt similarly, and the first rebuilds are now in service.

The M.R. classes which were adopted as standard for new construction were the well-known 4-4-0 compounds, the Class "2" 4-4-0 simples, the Class "4" 0-6-0 goods, and the 0-6-0 shunting tanks. All were built in large numbers. The compounds did fine work for many years, not only on their native section, but even more particularly in Scotland, where the C.R. and G. & S.W.R. men were quick to appreciate their capabilities. Except on the Birmingham expresses they have never seemed to do so well on the Western division. Very few L.N.W.R. men seemed to like them, probably owing to an inherited distrust of compound engines dating from Webb days. Properly handled and understood they have shown themselves capable of fine work. On fast and not too heavy expresses they are ideal, but during the war years this type of train of necessity largely disappeared, and gave way to heavier trains with more stops, with the result that these engines have had to be used largely on duties for which they are unsuitable. Even so, they are an outstanding design, and the only really successful compounds this

country has seen. Apart from the two surviving L.N.E.R. Robinson Atlantics from the former G.C.R., and one or two narrow-gauge tanks on the N.C.C. lines in Ireland, they are the only compounds still running in Britain. One wishes that one of them could be rebuilt experimentally with long valve travel and a modern front end.

Before leaving the subject of compounding, to which the L.M.S.R. under Fowler was giving serious consideration in its early years, mention must be made of three other designs of the period. The only one of these that actually materialised, was a rebuild of one of Hughes' 4-6-0's, No. 10456. As converted, the engine did very well, but Stanier, who succeeded Fowler and Lemon, was not an advocate of compounding, and as a result the L.M.S.R. took no further interest in the engine ; it was broken up in 1936. Sir Henry Fowler prepared designs for an enlarged 4-6-0 version of the Midland 4-4-0 compound, and in 1926 for a Pacific compound, preliminary work on which was actually started before being abandoned. It is the greatest pity that this machine was never built. If the magnificent work of the compound Pacifics on the Northern of France can be taken as any criterion, it would have been an experiment of the greatest importance, and might well have had a revolutionary effect on locomotive design in this country. The later compound designs of Chapelon in France have done even more amazing work than the previous Nord compounds.

Space does not permit reference to any of the other " might-have-been " designs evolved about this time, of which there were several, but going back again to what may be called the " Midland period," the adoption of the Class "2" passenger engine was perhaps the weakest of the choices for adoption as standard types. Very likely this was dictated by the design's marked superiority, from a maintenance point of view, over other contemporary classes, but one wonders whether this aspect was not given too much prominence. The adoption of the Johnson " 700 " design of Class " 3 " might have been a happier choice, even at the expense of higher costs of maintenance and coal consumption, for this was a reliable design and did yeoman service on Midland main line work. The extra power advantage over the Class " 2's " would have been an advantage on the G. & S.W. section and elsewhere. As it is, over half of the fine " 700's " have been scrapped, and the rest have been allowed to deteriorate into a poor condition and are used on any odd jobs and freight work.

Little need be said about the Class " 4 " goods, now 772 strong and the second most numerous class in the country. A useful general purpose modern superheated 0-6-0, it may be seen doing good work on nearly all parts of the system. The 0-6-0 tanks similarly proved most suitable for general shunting work, and, in a few cases, for branch line working, though their adoption for the steam suburban services of the former North London Railway was perhaps more questionable. This period also saw the perpetuation in small quantities of what may be regarded as a semi-standard type, the successful design of 4-4-2 tank which originated on the old L.T. & S.R. Ten further engines of this class were built at Derby in 1923, followed by five from outside builders in 1925, while Derby added another ten in 1927 and a final ten in 1930.

The year 1925 also saw the building of a further ten 0-4-4 tanks of the Caledonian design, definitely not as a standard type, but as a temporary measure to meet the urgent need of engine power. Apart from ten special outside cylinder 0-6-0 tank dock shunters, now Nos. 7160-7169, Fowler's first purely L.M.S.R. design was the 2-6-4 tank, the first of which appeared in the same year. With subsequent modifications by Stanier, such as

the provision of a taper boiler, the class now numbers close on 500 engines, and is still being built. This is one of Britain's most efficient suburban and express tank designs.

The smaller 2-6-2 tanks followed in 1930, and now total 209 engines, later ones being similarly modified with taper boilers. In 1929 also Fowler designed a heavy 0-8-0 mineral engine, again possessing typically Midland features and representing what a Midland 0-8-0 would have been like if they had ever had one. Of these 175 in all were built. Finally, Fowler built 52 new 3-cylinder 4-6-0's similar to, but smaller than, the " Royal Scots " and these engines were consequently nicknamed as " Baby Scots," though officially they are the " Patriot " subdivision of the Class " 5XP " 4-6-0 engines. They may be said to represent an imaginary Midland 4-6-0.

The advent of Sir William Stanier in 1932 caused a complete revolution in L.M.S.R. locomotive design. To start with, only the first five of a new batch of 4-4-0 compounds under construction were completed ; the order for the rest was cancelled. Stanier's first engines were five 0-4-0 saddle tanks and ten 0-4-4 tanks of no particular interest, but after that he really got down to tackling the problem of replacing what still remained of the less efficient classes inherited from the old companies. After constructing forty more 2-6-0's modified to his own design and fitted with taper boilers, his well-known Class " 5 " mixed traffic 4-6-0's appeared. In these he provided the company with what is now an extremely large stud of probably the most useful class on any line in the country. Equally at home on expresses (except the very fastest and heaviest), semi-fasts, local stopping trains, fast and slow freights, and even shunting duties if necessary, there is no work to which these engines cannot be put, and it is small wonder that they are popular equally with the operating department, shed staffs and drivers.

Stanier also continued Fowler's designs of 3-cylinder 4-6-0, 2-6-4 tank, and 2-6-2 tank, in each case modifying them with his taper boilers, and at the same time brought out the first two of his fine Pacifics, Nos. 6200 and 6201. No. 6202 was turned out as a turbine locomotive, and has continued as such ever since, successful when on the road, but with considerable periods, often many months, spent in the works. Pacifics Nos. 6203-6212 followed in 1935, and an improved version appeared in 1937, Nos. 6220-9 with streamlined casing and Nos. 6230-4 unstreamlined, followed by others since.

To complete the series of Stanier designs, there are the 2-8-0's of the " 8000 " class, the first of which came in 1935. Some years before, the Midland had built at Derby a class of eleven 2-8-0's to Fowler's designs for the Somerset & Dorset Joint Railway, though the M.R., curiously enough, never adopted this design for its own use ; these engines are Nos. 13800-13810 in the present L.M.S.R. locomotive stock. But the Stanier engines were of an entirely new and more efficient design. Large numbers were being built during the war by outside firms both for the L.M.S.R. and for the Government ; and a number of them went overseas on active service, and have since been sold to the Egyptian State Railways, and other lines. Many more have been built for the L.M.S.R., not only in its own workshops, but—an unprecedented event—by all three other groups also, at Brighton, Ashford, Swindon, and Doncaster. The L.N.E.R. has even built some of the same design for its own use.

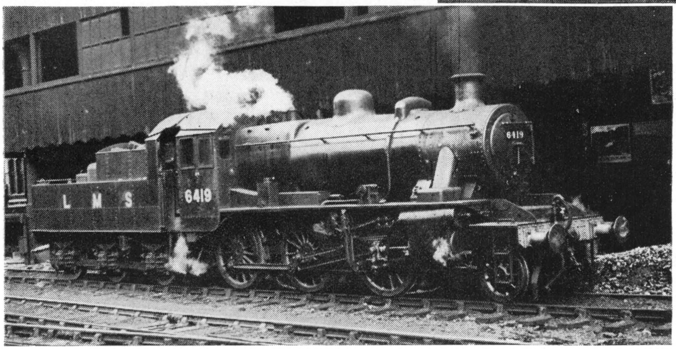
A recent L.M.S.R. decision has been to concentrate on eleven different types for future construction. These are the " Duchess " Pacifics and the rebuilt " Royal Scot," " Jubilee " and " Patriot " 4-6-0's for the heaviest passenger work, Class " 5 " 4-6-0's for mixed traffic, Class " 8F " 2-8-0's for heavy freight and the new Class " 4 " 2-6-0's for

BRITISH MOTIVE POWER DEVELOPMENT DURING 1947

L.M.S.R.

Many more of the "Royal Scot" 4-6-0's, and the first of the "Patriot" 4-6-0's, have been rebuilt with taper boilers: No. 6120, *Royal Inniskilling Fusilier*, is seen on the right passing Tring with an up Manchester express

[F. R. Hebron]



Two new light classes have been built—the "6400" series of tender 2-6-0's, and the "1200" series of 2-6-2 tanks

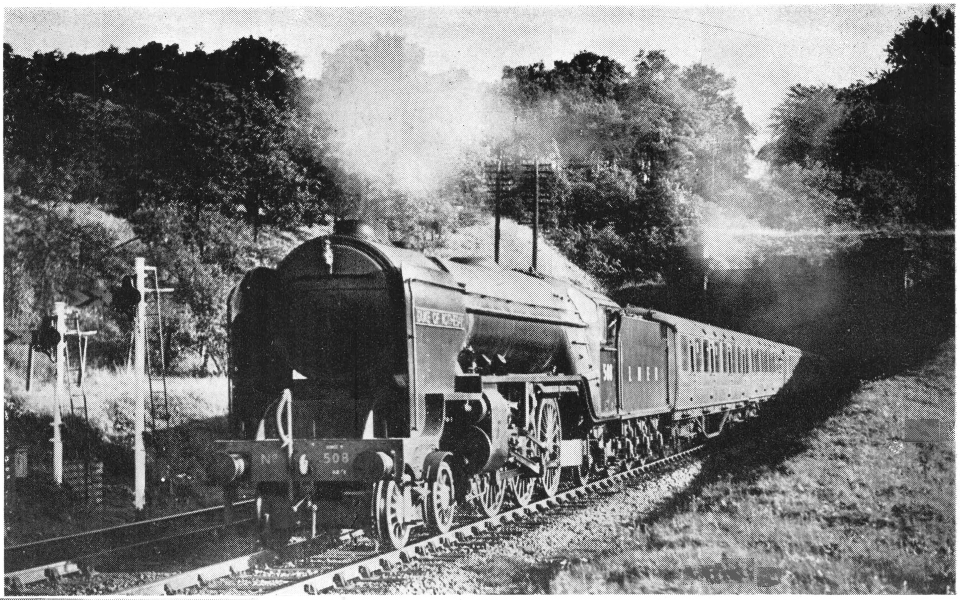
[Photos by H. C. Casserley]

Rapid progress has been made in building the successful Class "5" 4-6-0's, which now number well over 700 engines: No. 4774 is seen here with a freight train at Gargrave, Midland Division

[Canon E. Treacy]

L.N.E.R.

There has been a steady building of Thompson Pacifics with 6 ft. 2 in. driving wheels. On the right No. 508 *Duke of Rothesay* (Class "A2/1") is seen at the head of a down "slow" to Peterborough [*F. R. Hebron*]

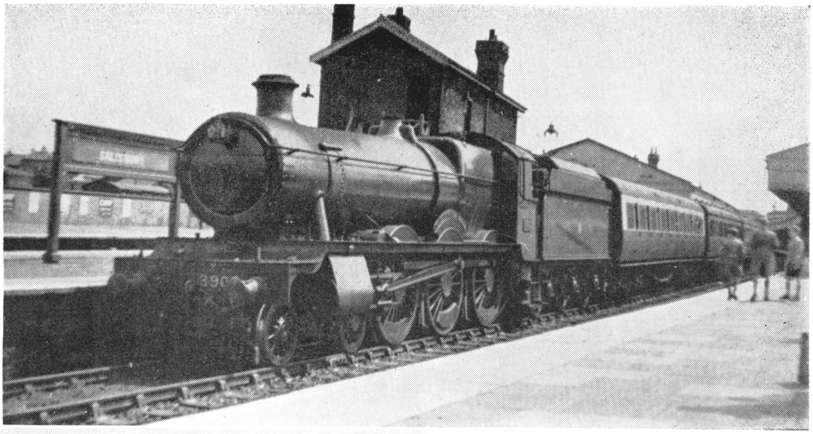


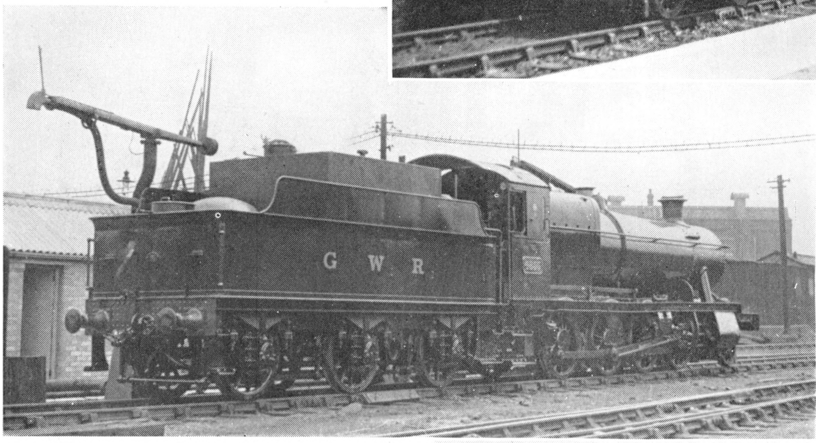
A number of the "Austerity" standard 2-8-0 locomotives built during the war has been taken into L.N.E.R. stock, and classified as "O7." One of these locomotives is seen on the left hauling an up freight train near Hatfield [*F. R. Hebron*]

The Thompson "B1" or "Antelope" class has been multiplied rapidly. No. 1153, on the right, is passing Godley with the 3.50 p.m. express from Manchester to Marylebone [*P. Ward*]

G.W.R.

On the Great Western, the fitting of locomotives for oil-firing has made further progress than on any other British railway





Above : Oil-fired 4-6-0 No. 3902, *Northwick Hall*, is seen at Salisbury [*G. O. P. Pearce*]

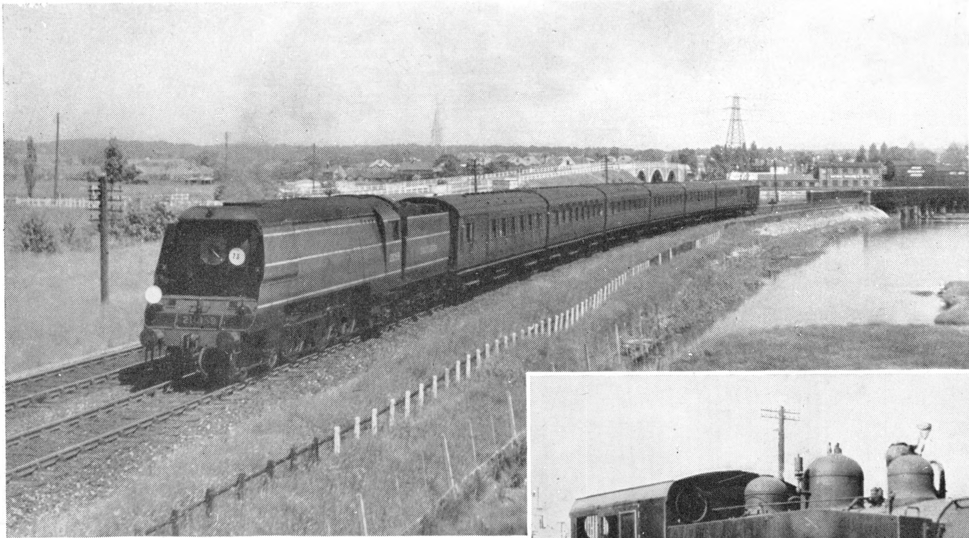
Left : One of the oil-fired 2-8-0 engines, No. 4855, at the Swindon fuelling plant [*H. C. Casserley*]

A new locomotive class during 1947 has been the "9400" series of pannier tanks with standard taper boiler, as seen on the right

Furtner progress has been made in building the new "County" class 4-6-0's, with 6 ft. 3 in. driving wheels, and 280 lb. pressure. The photograph shows No. 1007 on a down Plymouth express at Cholsey [*M. W. Earley*]

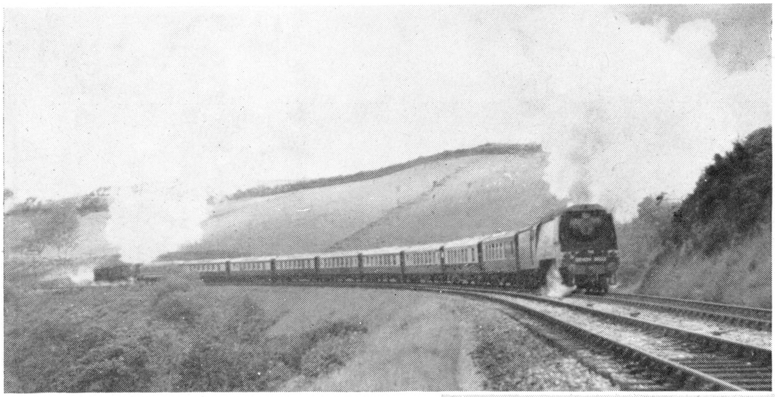
S.R.

New locomotive building has concentrated on Pacifics of the "West Country" and "Battle of Britain" classes



A Southampton-Bournemouth train passes over Redbridge causeway behind 4-6-2 No. 21C139, as yet unnamed [*F. F. Moss*]

On the right is one of the American-built 0-6-0 tanks taken into S.R. stock during 1947 [*A. F. Cook*]



A unique spectacle—the up "Devon Belle" Pullman climbing the 1 in 36 from Ilfracombe to Mortehoe with "Pacifics" both fore and aft—train engine No. 21C105, *Barnstaple*, and banker No. 21C102, *Salisbury* [*R. W. Beaton*]

First steps have been taken in fitting S.R. locomotives with oil-firing. Oil-burning "T9" 4-4-0 No. 305 here is seen piloting "B4X" 4-4-0 No. 2071 on a Cardiff-Portsmouth train near Nursling [*F. F. Moss*]

medium freight work, the new light 2-6-2 tanks and their 2-6-0 tender version for weight-restricted branches, and for shunting the standard 0-6-0 "Jinty" tanks, the diesel 0-6-0's, and the smaller "7160" class 0-6-0's for dock work. No more 4-4-0's or tender 0-6-0's are to be built, but the stock of the latter, including 772 of the Midland design alone, will last for many years to come. Experimental diesel-electric locomotives also are under construction, to be used in pairs on fast and heavy main line work, and singly on suburban and branch lines.

In spite of the wholesale withdrawal of engines of pre-amalgamation days, many still remain. Of all the locomotives which came into the L.M.S.R. stock, those of the former Caledonian Railway have lasted the best, a larger proportion of these being still extant than any of the other constituents. Next comes the Midland, but this is hardly surprising in view of the standardisation of Midland types during the early years. At the other end of the scale comes the Glasgow & South Western Railway, out of whose stock of over 500 engines only two still remain at the time of writing. The smaller North Staffordshire line, with about 180 engines, has suffered even worse, as none at all of these is left in the service of the L.M.S.R. Company, although one or two have been sold to private undertakings ; the Furness Railway locomotive stock also has almost completely disappeared.

Of all the main trunk lines in the country that of the former L.N.W.R. is probably the one which has been most completely transformed from a locomotive point of view during the last fifteen years or so, at any rate as far as express passenger types are concerned. One can still find Midland compounds on semi-fast main line work on the L.M.S.R. Midland Division, a few Ivatt Atlantics on the Great Northern main line of the L.N.E.R., Wainwright engines on the South Eastern & Chatham routes of the S.R., and so on. Liverpool Street of the L.N.E.R. still retains much of its Great Eastern atmosphere, while it is difficult to imagine the Great Western ever becoming anything other than the Great Western. But on the one-time "Premier Line" one looks in vain for *Shamrock*, *Helvellyn*, *Moonstone*, and all the rest of them. Possibly a grime-encrusted *Lusitania* may wheeze asthmatically by on a stopping train as a pathetic reminder of days gone by.

Nevertheless, however one may regret the passing of such old favourites, it cannot be denied that they could not possibly handle the trains of to-day, with their ever-increasing loads, and faster schedules. The "Royal Scots," together with the "Pacifics" and "Jubilees," have revolutionised traffic working on the main line of the old L.N.W.R. It is all the more pity that no attempt is made nowadays to keep these splendid machines even decently respectable, let alone up to anything like pre-war smartness ; and the unenterprising decision to continue with war-time black is in marked contrast to the reversion to bright liveries of the other groups. True, the largest engines are having restored a slight splash of pre-war red—or maroon, as it has now become—but surely this might be extended at least to the ubiquitous Class "5" mixed traffics and the 2-6-4 tanks, working on so many sections to which the larger engines do not penetrate. One pleasing development—this may be only a personal opinion, but it is shared by many—is the decision to remove the ugly streamlining from the Pacifics. From the point of view of reducing air resistance, this has proved of negligible value, and has increased the cost of maintenance. From the purely aesthetic aspect, a bulbous and shapeless mass now emerges as a really impressive and, by modern standards, a beautiful locomotive, a thing of grace and power.

LIFE ON AN INDIAN TROOP TRAIN

By Gordon Lack

SO our destination was to be India ! As the troopship *Strathaird* slid through the glassy seas of the Indian Ocean, I cast back to remember what I, as a confirmed " railwayist," knew about Indian railways. Not much, I decided—apart from boyhood recollections of pictures showing tigers standing defiant in the path of oncoming trains, and English-looking locomotives that sprouted such Transatlantic appendages as cow-catchers and large headlamps. Now I was going to see a whole new country and its railways, and I awaited the prospect with mounting curiosity.

First glimpses were reassuring. Our troop train awaited us amid the bustle of Bombay Docks—eleven freshly-painted coaches glistening in a chocolate-and-cream livery nostalgically reminiscent of the far-off G.W.R. Large yellow letters " B.B.C.I." were inscribed on the chocolate, and my Indian railway lore was sufficient to tell me that we were bound for Delhi by way of the Bombay, Baroda and Central India Railway.

Soon we were scrambling aboard, laden and perspiring with our kit. Seats were of the wooden, slatted variety, for this, being a troop train, was composed entirely of " thirds," apart from one second-class compartment for the officer in charge of the train ; but at least everything was clean under a fresh coat of dull red paint. Each carriage was split up into three large compartments with interconnecting doors. Some seats were cross-wise, some were lengthwise and each was duplicated by an upper berth above it. All eleven coaches were labelled " Military Rake No. 21 " ; these rakes were very rarely split up and were composed of some of the best coaches on the Indian railways.

Hardly had we partaken of the inevitable cup of " char," as we were learning to call tea, when we were off, headed by a large black 2-8-0 of the B.B.C.I.R. First we crawled over the busy lines of the Bombay Port Trust system, a separate administration which covers the many miles of dock lines and the connections to the main trunk railways.

Eagerly we looked about, avid for new impressions. Everything seemed so alive—the vivid sunshine, the glaring whites and blues and pinks of the houses, the swarming coolies, and the surprising profusion of bright green trees, each with a figure or two squatting in its welcome shade. Wharves and sidings seemed to be laid out on a scale unusually lavish to us. Then, with a thrill, I saw another black 2-8-0 similar to our own, but with a squat stovepipe chimney like that of the old Urie engines of the L.S.W.R., and big brass initials on its tender : " G.I.P." It was my first contact with what I have always thought one of noblest names of the railway world, the Great Indian Peninsular.

Shortly afterwards, we passed over this railway's main line out of Victoria Terminus, Bombay ; a well-kept four-track route electrified on the 1,500-volt D.C. overhead system. As we rumbled overhead on a long bridge, one of the few named trains of India passed underneath, the "Deccan Queen", on its way to Poona, hauled by a G.I.P. electric locomotive of the 2-D-D-2 type. Electrification must be particularly valuable on this route, which climbs over 2,000 feet up the Western Ghats.

Soon we joined the B.B.C.I.R.'s own main line out of Bombay Central, which was similarly electrified. The scrupulously neat track maintenance and the signalling system

were unmistakably British ; one could have been passing through the English shires save for the palm trees and the exotic names on the frequent electric trains. These B.B.C.I. electrics appeared to be identical with those of the G.I.P. except for colour ; the latter railway favours a dull lake, darker than the L.M.S.R. A feature was the presence of thin horizontal metal bars across all windows, presumably to discourage travellers from entering by this unorthodox means—a necessary precaution in India !

Just after passing the last of the electrification, we halted at a small station—our "Tea Stop," so higher authority informed us. Before even the train had come to rest, the beggars were alongside, ranging in age from 1 to 100, it appeared, with young India predominating. Their whining "*Bakshish, Sahib,*" never ceased until once more we were moving too fast for their rickety legs. New recruits to the Indian scene, as we were, we tossed a few coins, which merely redoubled their appeals, and I fled hastily to the platform for a stroll.

It resembled Victoria on a summer Saturday morning. Despite very English-looking ticket-collectors in smart uniforms, no power on earth can stop the Indian from treating a station platform as a home from home, a source of entertainment, and even as a dormitory. The entire inhabitants of the village (except those that were on the other side of the train, begging furiously) had turned out to look at the "soldier-sahibs."

Jostling through them came the railway-licensed seller ; "*pani-wallahs*" dispensing water from earthenware jars (one for Hindus, another for Muslims) ; "*char-wallahs*" with their brightly-polished tea-urns and little cups ; sellers of fruit and unimaginable fly-blown sweetmeats, carrying little stands made of cane upon which they set their trays when they had tracked down a customer. Through all this bustle strolled the imperturbable railway police in their blue or khaki uniforms, and the Eurasian or Indian railway officials in spotless white ducks ; the blinding whiteness of their topees—infallible sign of importance—contrasting strangely with the clouds of dirty grey smoke pouring from the engine chimney.

While we were halted, the "Frontier Mail" roared through on the middle road, on the first lap of its 1,450-mile run from Bombay to Peshawar—a flashing glimpse of chocolate-and-cream coaches mixed with the duller red of the North Western Railway's stock, and an all-white air-conditioned coach in the middle. This was one of the few named trains of India that was not withdrawn during the war ; it was a fast mover, even by European standards, and whenever I saw it, it was headed by one of the B.B.C.I.R.'s rare Pacific locomotives. In common with most Indian systems, the B.B.C.I.R. used 4-6-0's for almost all passenger work, with the ubiquitous small-wheeled 2-8-0 and 0-6-0 for goods traffic. The G.I.P., however, favoured the small Pacific passenger type.

Several nights later we jerked to a standstill at midnight amid the bright lights of Delhi Junction, main station for the capital city. I awoke with a start from uneasy slumber—but I rubbed my eyes all the more when I looked out of the windows. The platform opposite was literally covered with dozens of bodies clothed from head to foot in white sheets, for all the world like some infernal *morgue* of lost travellers. Old and young, well-to-do families on garishly-striped blankets, and poor ones on the hard platform, there they slept ; dead to the world despite jabbering porters and incoming trains. It was an unforgettable example of the Indian's patience and knack of being able to curl up and sleep at any time, anywhere.

Delhi Junction, although owned by the North Western, is used by the trains of the

G.I.P., B.B.C.I. and East Indian Railways, making it something like Carlisle must have been in the pre-grouping days. Opposite us was the Calcutta-bound "Howrah Express" of the E.I.R. The air-conditioned coach was an inviting symphony in green; the almost apple-green E.I. livery, with the light green anti-glare glass of the windows and the green-painted interior colour scheme, combined to make a refreshingly cool picture on a night when it was still warm enough for the slightest exertion to make one perspire.

Most of the compartments accommodated six, but not so many when the seats were converted from day to night use ; there was a small cubby-hole for the attendant at the end of the corridor. The coach was also fitted with connections which linked it to the adjacent restaurant-car—a very unusual refinement for India. I noticed, incidentally, that the restaurant-car was not air-conditioned ; there must have been a rise in temperature in passing from one to the other ! But the deliciously cool green leather seats, the faint hum of the air-conditioning, and the white-clad attendant, all made me very envious after my hard and fan-less travel. A supplement over and above first-class fare is charged for these coaches, which are irreverently known among the British community as " frozen meat wagons," but are none the less welcome !

After a scorching hot day at Delhi (I vividly remember washing a shirt and wearing it bone dry within half-an-hour), we said goodbye to our military train and departed in an ordinary " semi-fast " for Lahore. There was a certain confusion about reservations, only one carriage having been provided by the railway authorities for our party ; this was obviously inadequate, and after a great deal of excited arguing, the hapless passengers in a third-class coach were bundled out by the assistant stationmaster and, after a perfunctory clean-out by " sweepers," this was handed over to us. Having seen some of the curious things which the sweepers' brooms had brought to light, we regarded our future home with mixed feelings. As we were " rookies " in India, the awful warnings of the medical officers on the ship were still in our ears, and we entered the carriage firmly convinced that we should soon fall a prey to every disease in the Indian calendar. As it turned out, we did suffer by the unexpected commandeering of the coach, but not quite in the way anticipated.

Instead of a 2-8-0, we now had a N.W.R. 4-6-0, trim in black livery with brightly-polished copper bands around the boiler. The N.W.R. was the original State-owned railway of India, and obviously the beautifully-laid double track was designed with an eye to military communication as well as civilian traffic ; for this is the route to the " Frontier." The improvement in agriculture was very noticeable as soon as we crossed into the Punjab ; the name actually means " five rivers," and continually the line crossed rivers and canals watering the flat, vividly-green land. As we travelled north-westward, we caught increasing and tantalising glimpses of the great hills on our right.

Early next morning we rumbled under the roof of the large, old-fashioned station at Lahore. As in the West, modern Indian stations have dispensed with the all-over roof in favour of separate umbrella-type roofs for each platform. The scene that greeted us as we rolled in was the very opposite to the sleeping figures of Delhi. The wide platform was a seething mass of white-clad humanity, with here and there the brighter colours of the women-folk—all buzzing like bees and determined to find a place on our train. Even educated " *babus*," clutching the inevitable umbrella, and the better-class Punjabi men, very dandified in their close-fitting long white coats and pillar-box hats of silver and gold, had thrown their superior manners to the wind and were pushing like the rest.

To see this horde attack the third-class coaches was a sight to make the most hardened London tube traveller shudder. One stout old lady was being pushed through the window by a perspiring porter, and my companion told me that she was complaining bitterly at having to tip him for his aid. But eventually all were squeezed in and those lucky enough to be near the windows settled down happily to the travelling Indian's main occupation at stations—watching the antics of late-comers trying to get aboard and the haggling of vendors upon the platform.

Lahore is a busy station by Indian standards. In 1944, 84 passenger trains and 35 goods trains entered the station every twenty-four hours, since it is the junction where the Karachi "spur" joins the great backbone of the N.W.R.'s system from Delhi to the Khyber. But I shall remember it chiefly for its all-pervading flies, and for a heavenly glass of iced lager which I bought very cheaply in the second class restaurant. Indian stations have to be well supplied with feeding accommodation; first class or "*pukka sahib*" restaurant, second class ditto, and separate restaurants for Hindus and Muslims. All four divisions have to be duplicated in the waiting rooms also.

Nearly all military journeys develop a "snag" at some point or other; and our comparatively smooth progress so far should have warned us. At the tender hour of 7 a.m. next morning we were awakened at Lalla Musa Junction by a very surprised stationmaster. The remainder of our party (in another coach) had departed with the rest of the train ten minutes ago; our own carriage, which had been commandeered for our use so perfunctorily at Delhi, apparently was in the habit of being transferred at this point to a train bound back to Delhi. The authorities had omitted to tell us of this little detail; only the fact that a chance porter had glanced in at the window had led to the discovery that the coach was full of members of H.M. Forces fast asleep. The stationmaster was sorry, but back the coach must go, and in five minutes, too.

Never did so many men so feverishly pack so much baggage in so small a space; thinking that we were in for a journey of some days, we had well spread our belongings. Also, it happened to be the first night that, most painstakingly, we had erected our new mosquito nets. But in five minutes everyone somehow had struggled on to the platforms, nets and all, and we were gloomily watching our late home returning back by the way we had come. Tempers were not improved by finding that the first four lucky applicants at the little station refreshment room had exhausted the supply of breakfast!

By tea time, however, we were united once more with a mirthful party at Rawalpindi. A few hours of travel brought us to Taxila, where we changed into a very English-looking local train, consisting of a 0-6-0 tank engine and four coaches, which meandered up a pleasant mountain valley in the twilight of a perfect summer's evening. By 11.30 p.m. we had arrived at Havelian, journey's end as far as the rail was concerned, and one of the most northerly terminals of India. It was curious to look at the snow-capped mountains to the northwards, and to realise that the nearest rails in that direction were in far-off Russian Turkestan. The final eight miles to our destination were completed with a flourish that only Oriental driving can put into road travel, and at 4 a.m. we crawled wearily into bed at the military camp in Abbottabad, North West Frontier Province, over 1,300 miles from Bombay. We had spent more than ten days on the journey and risen over 3,000 feet in height, having left the sea in sweltering heat and arrived muffled up in our thick army greatcoats. But, as a journey, I had enjoyed every mile of my first trip on India's railways.

A FAMOUS LOCOMOTIVE CLASS

The Great Northern Atlantics

By Cecil J. Allen, M.Inst.T., A.I.Loco.E.

AN epoch in British locomotive history was marked when there appeared from Doncaster Works of the Great Northern Railway, in the summer of 1898, an engine destined to be the forerunner of one of the best-known classes in this country. It introduced into Great Britain a new wheel arrangement which remained standard for express passenger work on the Great Northern for almost exactly a quarter of a century, and which soon spread to the other East Coast partners—the North Eastern and the North British. Moreover, in many essentials it laid the foundation of London & North Eastern express locomotive practice for a second quarter of a century—from the time of the grouping up to the forthcoming loss of the company's identity by nationalisation.

The engine concerned was No. 990, designed by Mr. H. A. Ivatt, numbered 769 in the works records, and shortly afterwards named *Henry Oakley* in honour of the then chairman of the G.N.R. No. 990 was Britain's first Atlantic, beating by a short head Aspinall's first Atlantic on the Lancashire & Yorkshire Railway, which took the rails in 1899. The chief difference between them was that Aspinall chose inside cylinders, whereas Ivatt preferred outside cylinders, which enabled him to drive on the rear pair of coupled wheels with a connecting rod having the comfortable length of 10 ft.

Certain features of No. 990 were unusual. The engine was designed at a time when it was the fashion in Britain to build 4-4-0 express locomotives with big cylinders—18 in. or 19 in. diameter by 26 in. stroke in many cases—and small boilers. Steam could be made in indefinite quantities by lengthening the cut-off, even though this might involve a blast so fierce as to erupt fountains of sparks and cinders from the engine chimneys. So long as neighbouring fields were not set on fire, excessive consumption did not matter so very much, for coal was cheap.

But No. 990 went quite the other way. While the cylinder diameter was still 19 in., the stroke was shortened to 24 in. ; and these cylinders were mated to a boiler with 1,442 sq. ft. of heating surface and 26.8 sq. ft. of firegrate. The heating surface might have been larger but for the fact that Ivatt recessed his smokebox into the barrel, so cutting his tube length from a possible 14 ft. $8\frac{1}{2}$ in. to an actual 13 ft. Driving wheels were of the 6 ft. $7\frac{1}{2}$ in. diameter customary on the G.N.R. ; working pressure was 175 lb. ; and weight in working order 58 tons, of which only 31 tons was available for adhesion. Even with their tenders the first Great Northern Atlantics weighed only 99 tons.

After trials of No. 990 extending over two years, Ivatt turned out ten more small Atlantics in 1900, Nos. 949 and 950 and 982 to 989 inclusive, and another ten, Nos. 250 and 252-260, in 1903, making a total of 21. There was also No. 271, an experimental small Atlantic with four 15 in. diameter cylinders, all having the very short stroke of 20 in. and driving on the leading pair of coupled wheels, built in 1902. Nine years later this engine was rebuilt with two cylinders, and became unique as the only inside cylinder Atlantic on the G.N.R., and later on the L.N.E.R. ; it remained in service till 1936.

Between the emergence of the two batches of small Atlantics, however, something very important had happened at Doncaster. This was the completion near the end of 1902 of Atlantic No. 251. If No. 990 had been a revolutionary design, No. 251 was doubly so. For while the chassis of the latter engine was practically uniform with that of the first, the 4 ft. 8 in. diameter boiler of No. 990 gave place in No. 251 to one of 5 ft. 6 in. diameter—the first use in Great Britain of anything so large. Also Ivatt had made use of the rear-end development permitted by the Atlantic wheel arrangement to mount a firebox spread out across the entire width of the engine, and resting on the frames instead of dropped down between them.

At one stroke, with the increase in barrel diameter, and in effective length from 13 ft. to 16 ft., the total heating surface went up from 1,442 to 2,500 sq. ft., and the firegrate area was increased to 31 sq. ft. But perhaps the most remarkable change was that, with this considerable increase in steam-raising capacity, the cylinder diameter was *reduced* from 19 to 18¾ in. No such ratio as this of total heating surface and firegrate area to cylinder volume had ever been tried before in Great Britain. So, with boiler pressure maintained at 175 lb., the nominal tractive effort of the big-boilered No. 251 was actually less than that of the small-boilered No. 990 !

Once again a considerable time elapsed, while No. 251 was under test, before Ivatt did anything further, and it was not until 1904 that building of the large-boilered engines began in earnest. Curiously enough, though it was definitely said, while No. 251 was under test, that the frames of the small Atlantics had been so designed that they could be fitted with the large boiler if No. 251 proved successful, no attempt was ever made to rebuild any of the former in this way, and all reboilerings of the earlier engines were with their own 4 ft. 8 in. diameter boilers. Eventually the total of the large-boilered Atlantics reached 94, all but No. 251 built between 1904 and 1910 inclusive ; the numbers were 251, 272 to 301, 1300, and 1400 to 1461. All the Great Northern Atlantics added together thus made a total of 116 engines.

One of the large-boilered engines, however, was not an Ivatt design. This was No. 1300, a four-cylinder compound designed and built in 1908 by the Vulcan Foundry, supposedly on the same lines as the successful De Glehn compounds of the Northern Railway of France, but in no way even approaching the performance of the latter, to compete with No. 292 and No. 1421, two four-cylinder compounds of Ivatt design built at Doncaster in the same year. The chief defect of the Doncaster compounds seems to have been their unjustifiably small cylinders—high pressure no more than 13 in. by 20 in., and low pressure 16 in. by 26 in.—whereas the Vulcan compound may have suffered from precisely the opposite extreme, for its high pressure cylinders were 14 in. by 26 in., and low pressure as big as 23 in. by 26 in.

Whatever be the reason, none of the three compounds had any success. No. 3292 lasted as a compound until scrapped in 1927 ; No. 1421 was rebuilt in 1920 as a standard Ivatt Atlantic ; No. 1300 retained its distinctive boiler to the end, though rebuilt as a 2-cylinder engine in 1917, after which it ran for seven years until broken up in 1924. Under L.N.E.R. auspices, of course, the three engines were renumbered, and took the numbers 3292, 4421, and 4300 respectively. Nos. 1300 and 1421 were the only large-boilered Atlantics to run without extended smokeboxes. Other changes that were made in L.N.E.R. days were Gresley's rebuilding of No. 279, later 3279, with four simple cylinders and Walschaerts motion, in place of the previous Stephenson gear ; this took place in 1915.

Another rebuilding took place in 1938, this time with two 20 in. by 26 in. cylinders.

In 1923 Gresley made his first experiment with an American booster by fitting one to No. 1419, which at the same time was provided with a large cab with side windows, and later became No. 4419. No. 1447, renumbered 4447, was another Ivatt Atlantic changed a good deal in appearance by the cutting down of the boiler mountings and the substitution of a large cab ; the purpose in this case was to allow the engine to run over the North British section, but no others were altered similarly.

None of the experiments mentioned in the previous paragraphs had any effect on the class as a whole, or, so far as can be seen, any result of value. But another and much simpler change effected a most striking transformation in the work of the Great Northern Atlantics ; indeed, it was not until this change had been made that they began to make their unique reputation. For in their early years, strange to say, the big-boilered Ivatt engines were distinctly sluggish ; with loads of over 300 tons their timekeeping was anything but good. When I began my " British Locomotive Practice and Performance " articles in *The Railway Magazine*, from August, 1909, onwards, I aroused a great deal of controversy by comparing the performance of the London & North Western 4-4-0 " Precursors," which were then in their heyday, with that of the Ivatt engines, and the comparison was not flattering to the latter.

This is a reminder of the much more direct comparison that was made in June, 1909, when L.N.W.R. 4-4-0 No. 412, *Marquis*, was exchanged with G.N.R. 4-4-2 No. 1449 for comparative trials over the two companies' lines. It is most unfortunate that no records seem to be available of the way in which these competitors acquitted themselves. A little later on I remember raising a laugh at the Railway Club, when reading a paper on the Ivatt Atlantics and their work, by quoting a remark of the G.N.R. Chairman, Lord Allerton, at the shareholders' meeting, to the effect that " we have the best engines that money can buy," and then adding, on my own account, " but they seem to have a conscientious objection to keeping time on Mondays and Fridays." The reason was heavy week-end loads.

Well, the change to which I refer was, of course, superheating. It was in 1910 that Ivatt brought out the first superheated series, Nos. 1452 to 1461. These were new engines, and apart from the provision of the Schmidt superheater the only other changes of note were the enlargement of the cylinder diameter from 18¾ in. to 20 in., and the reduction of the working pressure from 175 lb. to 150 lb. Ivatt's idea behind the pressure reduction was that as no additional tractive effort was needed, it would be in the interests of boiler maintenance if the working pressure were reduced. This was a mistaken policy, however, and in later years the 175 lb. pressure was restored.

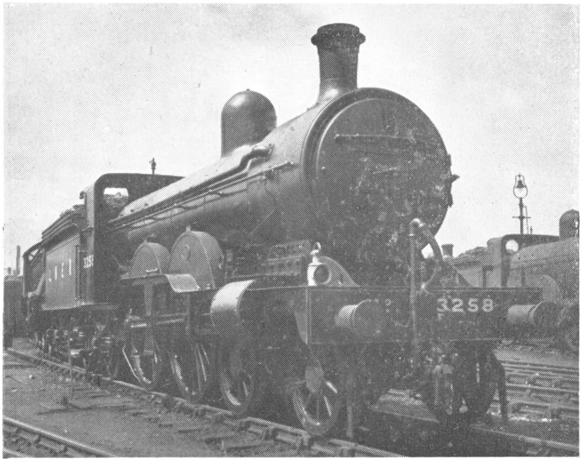
The new engines soon began to make a name for themselves, in the hands of the very competent drivers to which they were entrusted—particularly Rowley on 1458 and 1459, Waller on 1460 and Collarbone on 1461. To take one example, in the June 1912, issue of *The Railway Magazine*, I described a very fine run with the up " Flying Scotsman " on which Rowley, with No. 1458, hauling 390 tons, touched 86½ m.p.h. at Essendine, ran the rising stretch of 27 miles from Huntingdon to Hitchin at an average of just over a mile a minute, and completed the 105½ miles from Grantham to King's Cross in a net time of 112 minutes.

At the time this seemed an outstanding feat, though it was but a pale shadow of what the engines were destined to do in their later years. In any event, the success of

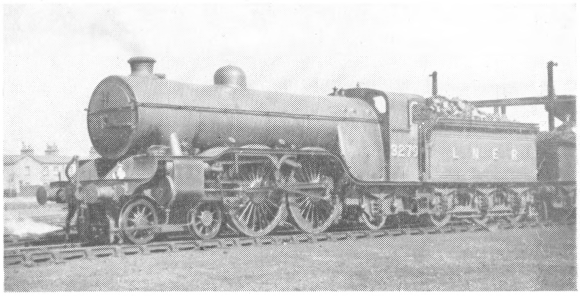
A FAMOUS L.N.E.R. LOCOMOTIVE CLASS—The Ivatt Atlantics

Right : No. 4419, which for a time was booster-equipped, rebuilt with large side-window cab [*W. S. Garth*]

Below : No. 3258, of the original small-boilered series, rebuilt with extended smoke box and superheated [*C. C. B. Herbert*]



Below : No. 3279, rebuilt in 1915 with four cylinders, in its final form after the second rebuild in 1938, again with two cylinders [*J. P. Wilson*]



Below : Their "finest hour"—A standard Ivatt Atlantic, No. 3284, heading the "Queen of Scots Pullman" [*M. W. Earley*]

L.N.E.R. VERSUS THE WEATHER JANUARY—MARCH, 1947

Snow and Ice—*right*, digging out an engine and snowplough ; *middle*, Barras Station, on the line from Darlington to Tebay, as it appeared on February 19th

Floods—Aftermath of the snow and ice period was the disastrous time of flooding in March. This was the appearance of the Cambridge main line near Tottenham Station on March 15th

[*L.N.E.R. Official Photos*]

the superheating was so pronounced that conversion of the saturated Atlantics to superheaters began at once, and in the course of time all the Atlantics, large-boilered and small-boilered alike, acquired superheating equipment.

It seems odd that the "finest hour" of these notable engines should not have come until long after Ivatt had relinquished the reins at Doncaster, nor until after the far more powerful Gresley Pacifics had become the standard L.N.E.R. main line locomotives for the heaviest duties. In all my lengthy travelling experience, the most remarkable evidence of this fact that I ever had was on the historic occasion in 1936 on which "A3" Pacific No. 2595, *Trigo*, ran hot one day when working the 1.20 p.m. express from King's Cross to Edinburgh, and had to come off at Grantham. The packed 17-coach load of 546 tons tare and 585 tons full was a man-size proposition for a Pacific, let alone any smaller engine. At Grantham, the only spare power available was Ivatt Atlantic No. 4404, and she was duly fetched and backed on in place of *Trigo*.

Starting on Grantham station curve was no easy job, and one or two reverses were needed before we got away; to pass Barkstone, 4·2 miles distant, took 8 minutes, 17 seconds. But after that the running was simply amazing. By Claypole we were doing 74 m.p.h.; over Markham summit, with long 1 in 200 approach grades, we never dropped below 48 m.p.h.; before Retford we had reached 77½ m.p.h. and along the level stretch between there and Doncaster speed was continuously at between 72½ and 75 m.p.h. save for a drop to 61 over Piper's Wood "hump." On the further level course north of Doncaster, after a slow to 55 m.p.h. through that station, speed got up to between 60 and 66 m.p.h., so that the 63·3 miles from Barkstone to Brayton Junction were covered in 59 minutes, 24 seconds—a performance undreamed of when the engines were designed, and when 300-ton trains—roughly *half* this load—were the rule at considerably lower schedule speeds.

After the usual severe slowing over Selby swingbridge, and a slight signal check outside York, we completed the 82·7 miles from Grantham to York in 87 minutes, 40 seconds, or 86½ minutes net—3½ minutes less than the Pacific's allowance of 90 minutes for the run. One striking feature of this journey was that the crew that took over No. 4404 at Grantham were not Great Northern men at all, but a North Eastern driver and fireman from Gateshead; and when I spoke to Driver Walker on alighting at Darlington, I found him quietly enthusiastic about the Ivatt Atlantic design—a tribute indeed to its sterling merits.

On another occasion, and again at Grantham, No. 4401 was called on suddenly to take over the up "Yorkshire Pullman" from an "A3" Pacific which similarly had run hot. From Rowley's running times with No. 4458 in 1912, which at that date seemed so outstanding with his 390-ton train, No. 4401 with 380 tons deducted 8½ minutes, running the 105·5 miles in 104 minutes, 35 seconds start to stop. The Atlantic averaged 74·7 m.p.h. from Huntingdon to Arlesey, and 65·3 m.p.h. for the 97·6 miles from Stoke Summit to Finsbury Park, including the dead slowing through Peterborough.

It was on the Pullmans that the Ivatt Atlantics undoubtedly achieved their greatest fame, and many drivers, like the redoubtable Bill Sparshatt, also first established their reputations on these workings. The "Queen of Scots" in particular, with its non-stop run between King's Cross and Leeds, its seven-car load of a little less than 300 tons, and the average speed of something over a mile-a-minute needed for the major part of the distance, seemed ideal for these capable machines; drivers also had little difficulty in

recovering lost time if delays were experienced. As to speed, on one notable down journey in August, 1936, No. 4460, at the ripe age of 26 years, with 275 tons behind the tender, touched 90 m.p.h. at Three Counties, averaged 83·0 m.p.h. for 30·3 miles from Stevenage to Huntingdon and 78 m.p.h. for 54¾ miles from Hatfield to Yaxley!

In their final form, the Ivatt Atlantics have 6 ft. 8 in. driving wheels, 20 in. by 24 in. cylinders, 2,533 sq. ft. combined heating surface (including superheater), 31 sq. ft. of firegrate, 170 lb. pressure, a tractive effort of 17,340 lb., and a weight in working order of 69½ tons, of which 40 tons is adhesion weight. With a tender carrying 3,500 gallons of water and 6½ tons of coal, the total weight in running trim is 112¾ tons. Now that the history of these fine engines is nearing its end, and they are rapidly making their last melancholy pilgrimage to the scrap-heap, it is at least some consolation to hear that No. 3251, the original No. 251 of 1902, after 45 years of hard and unremitting work, is likely to join No. 990 as a permanent exhibit in the York Museum.

BRITAIN'S BIGGEST A.C. ELECTRIFICATION

The Original Overhead System of the Brighton Line

By E. R. Lacey

AS far back as 1903 the London, Brighton & South Coast Railway had made plans to electrify its South London line between London Bridge and Victoria ; and in that year it was authorised by an Act of Parliament to carry out the project. By this venture it was hoped to increase suburban traffic receipts, which had been declining gradually owing to tramway competition. The matter had become more urgent as the London County Council had commenced the electrification of its tram routes, and this was a further cause of anxiety to the Brighton Company.

The decision to adopt the high pressure alternating current system, with overhead contact wires, was influenced by the advantages that it offered over the direct current, third rail method. Among these were the fewer and simpler sub-stations required, the facts that switchgear and equipment in sub-stations need not be of such heavy construction, that feeder cables could be of smaller cross section, that bonding of the running rails at the joints was not essential, that no alterations to trackwork were required, and that there was no electrical danger to permanent-way men, shunters, or others.

With the high potential chosen (6,600 volts) the amperage of the current taken by the motor coaches was considerably lower than that associated with the third rail system, and made possible the economy in electrical equipment already mentioned. Furthermore, the Brighton authorities had in mind the ultimate extension of their electrified lines to Sussex coastal resorts, for which also overhead A.C. electrification would be more advantageous than the D.C. third-rail system, and so decided that the scheme best suited for long-distance use should be adopted for suburban working also in order that the rolling stock could be interchanged freely.

In 1906 a contract was placed with a German firm to supply the necessary electrical equipment for the South London line and for the coaches, which were built in this

country. After three years' preparation, a service of " Elevated Electric " trains—as the Company designated them—was brought into operation on December 1st, 1909. No more than three months of electrical working, it was stated, sufficed to double the traffic receipts in that area, though the reduced fares which became operative at the same time between the stations served by the new trains no doubt helped to attract some of the additional passengers.

In the following year, 1910, it was decided to extend electrical working to the Crystal Palace ; and by May 12th, 1911, a partial service was inaugurated over this route ; the full service began on the June 1st of that year. By 1912 trains were running on all the lines forming part of the Crystal Palace extension ; these comprised the services from either Victoria *via* Streatham Hill or from London Bridge *via* Tulse Hill, with occasional extended trips to Norwood Junction in order to work to or from the carriage sheds at Selhurst. A third route opened for electric working in 1912 was the spur line between Tulse Hill and Streatham Hill, over which another electric service was brought into use between Victoria and London Bridge.

Further developments were delayed through the intervention of the 1914-1918 war, and it was not until after the L.B. & S.C.R. had been absorbed in the Southern Railway, at the beginning of 1923, that the electric suburban trains reached East and West Croydon, Coulsdon and Sutton. The opening date of this extension, which commenced at Balham Junction, was April 1st, 1925. Before this date, the Southern Railway had decided that the D.C. third-rail system, already in extensive use in the Western Section (late London & South Western) suburban area from 1915 onwards, should be the future standard on all their lines, and the fate of the Brighton overhead A.C. electrification was thus decided. Trains with overhead equipment continued to run until September 21st, 1929, having shared the same metals with Southern third rail D.C.-equipped trains over certain routes for about a year. It may be noted that the general title " Elevated Electric," first adopted because the original Victoria-London Bridge route was mainly on a viaduct, was applied also to the later electrification by the Brighton Company of the Crystal Palace group of lines, but not to the Croydon, Coulsdon and Sutton group.

For working the Brighton trains, single-phase A.C. at 6,600 volts was supplied to the Company and fed to the distributing centres at Peckham, Tulse Hill, and elsewhere, and an initial contract was placed with an electric supply undertaking for a period of 17 years at a maximum annual consumption of 30 million units. From the distributing centres, current passed to a series of switch cabins directly connected to the overhead contact wires. The copper contact wire, of $\frac{1}{2}$ in. diameter, had two continuous longitudinal grooves to enable it to be clamped to the droppers, which were spaced at 10 ft. intervals. These in turn were suspended from a pair of multi-strand steel catenary wires, which spanned the 150 ft. spacing between each pair of overhead girders.

Contact wires normally were at 16 ft. above rail level, except at certain stations and sidings, where, to comply with Board of Trade requirements, the distance was increased to allow a greater clearance between the roofs of the coaches and the live wires. Towers, built up of steel channel sections, supported the overhead girders, which were of joist or lattice construction, and some were cantilevered out from the side of the track ; the latter were much in evidence between Clapham Junction and Pouparts Junction. On the South London line the lattice girders were " X " braced, but on the other lines bracing of the " N " type was used. From the signal observation point of view the advantage of

the latter method was that the " N " diagonals were arranged to slope at right-angles to the signal-arms applying to the tracks immediately below, when in the " off " position.

Contact wires ran in a continuous zig-zag over the track, being staggered 9 inches on either side of the centre line. This ensured a lateral sweep of 18 inches across the collector bows, and prevented a groove being cut in the latter. Each motor coach of the South London line and Crystal Palace extension was provided with two collector bows, one for each direction of running. Originally these coaches had an additional trailing arm, to ensure continuous contact with the overhead wire and so to lessen the amount of current collected by each of the aluminium slips with which they were fitted. To minimise the inevitable wear between wire and bow, the contact slips were grooved longitudinally and packed with graphited grease. After a few years running, however, it was found that the trains ran equally well without the extra trailing arms, and they were all removed.

On the more powerful motor coaches introduced in 1925 on the Coulsdon and Sutton lines, four collector bows were provided, two for each running direction, kept in contact with the overhead wire by pneumatic pistons that derived their air supply from the Westinghouse brake compressor, but they could be raised by means of air pressure supplied from a hand pump when necessary. Current passed from the bow to an underslung transformer on each motor coach and was reduced to 750 volts. Tappings were then available at 450, 580, 640 or the full 750 volts for speed regulation. An auxiliary transformer provided current at 300 volts for the train lighting, compressor motor, and controller circuits. All trains were operated on the multiple-unit principle, whereby any number of motor coaches in the formation have all their motors controlled from one driving position at the front or rear of the train.

The rolling-stock built for the South London line possessed features unusual on the L.B. & S.C.R. Except for Pullman cars, these 60 ft. by 9 ft. vehicles were the longest then in use on the line, and the widest suburban bogie coaches ever to appear on Brighton metals. Although of the compartment type, the coaches had an open side gangway throughout their length, which it was thought would save time when passengers entrained, especially as doors were provided in line with each compartment. This design was not perpetuated in any subsequent Brighton electric rolling-stock, however, but it was applied to a few " push-and-pull " trailers on the steam rail-motor services.

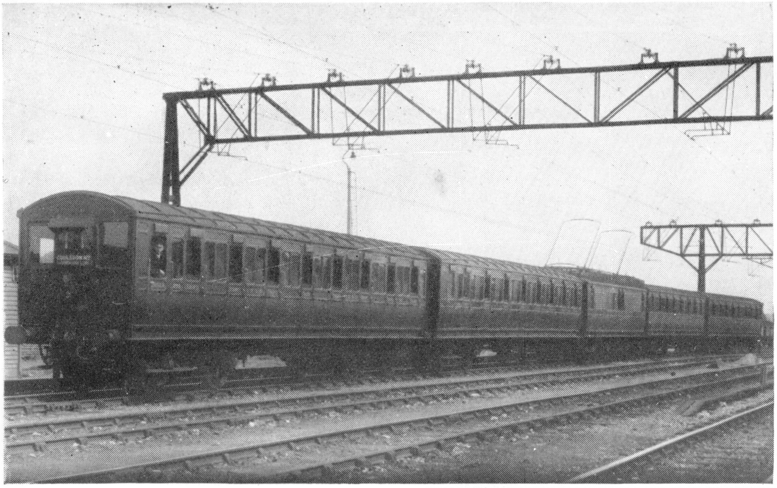
The girder construction of the underframes gave these vehicles a substantial appearance, as may be seen in the photograph reproduced of a three-coach unit in its original cream and umber brown livery. At each end of the unit was a third-class motor coach of 460 h.p., weighing 54 tons. Between the motor-brakes was a first-class trailer, with nine compartments, weighing 30 tons. The first-class accommodation was found to be in excess of requirements, however, and the alternative of three or six coaches only proved too inelastic for traffic needs. Consequently the first-class trailers were removed, and two-coach units were assembled, each consisting of a motor coach coupled to a first-and-third-class composite driving trailer that had been withdrawn from the Company's steam stock and adapted for the purpose. The latter vehicle was of smaller dimensions, measuring 48 ft. by 8 ft., and having a tare of $21\frac{1}{4}$ tons. The displaced coaches were relegated to steam services, principally between London and the coast, when they gained the nickname of " Ironclads " on account of the heavy underframes already referred to.

Each of the four axles of a South London motor coach was driven by a 115 h.p. motor through a reduction gear of 4.24 to 1 ratio. The high tension equipment within the

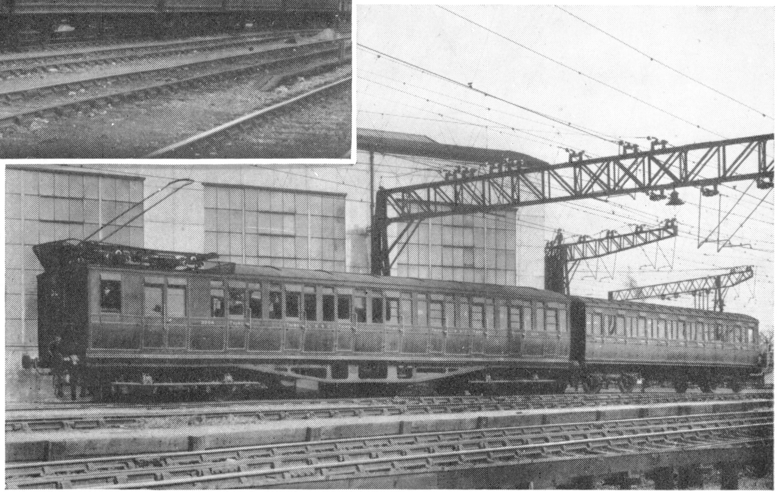
BRITAIN'S BIGGEST A.C. ELECTRIFICATION

Some of the original "Brighton" equipment

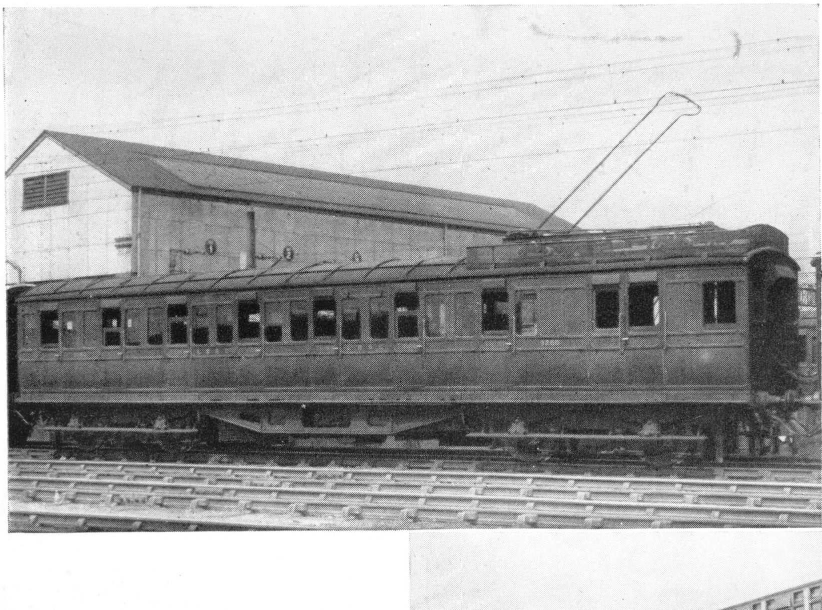
[*Photos by O. J. Morris*]



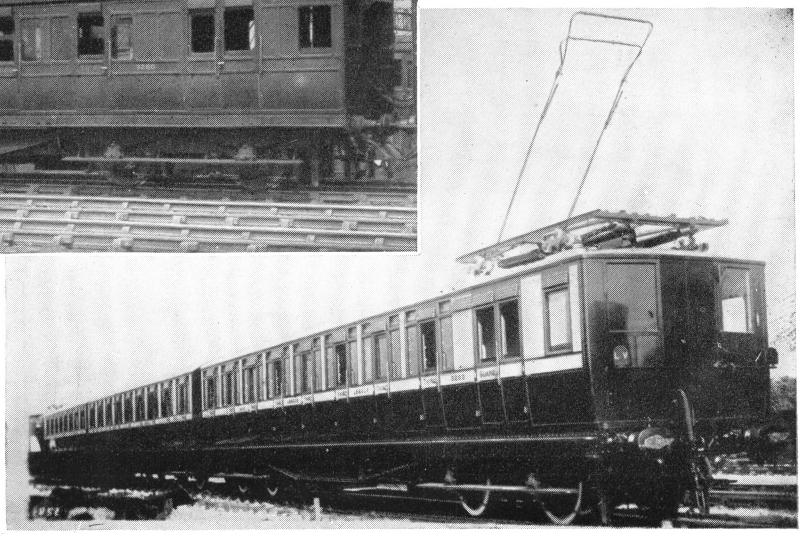
Above :
Standard train with central motor-van and four coaches for the Coulsdon and Sutton services



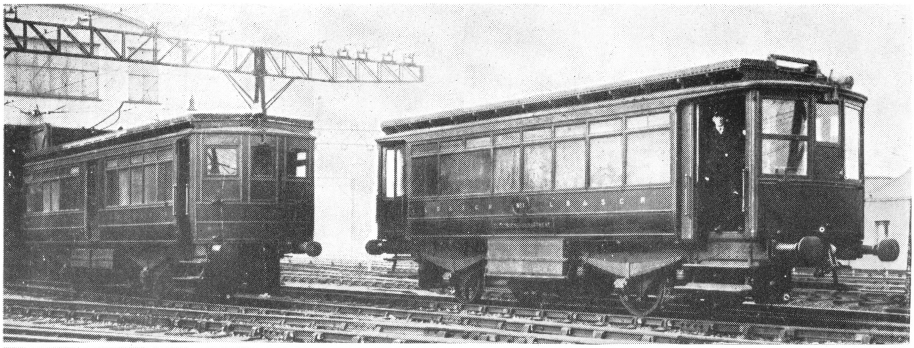
Right :
Modified 2-coach unit for the South London line, as running until 1928



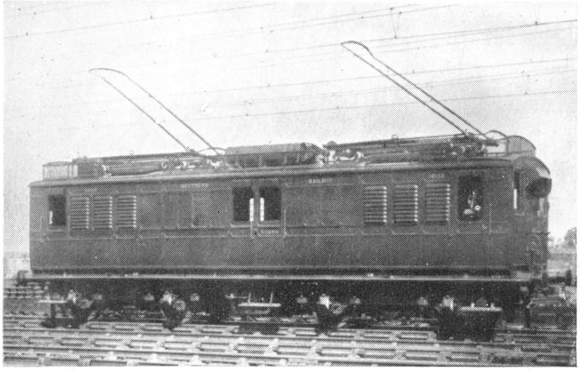
Left : Third class motor-brake of the stock used on the Crystal Palace line services



Right : Original 3-coach unit of the South London "Elevated Electric" service in cream-and-umber livery. Note trailer strip to collector bow, also "LV" (last vehicle) board carried on rear



Left : Petrol-electric rail-motors converted to serve as inspection and repair cars for the overhead equipment



1,000 h.p. motor-coach marshalled as the central vehicle in Sutton and Coulsdon units

1,000 h.p. motor-coach converted to a 27-ton guard's brake for freight trains

The last phase—overhead structures at Clapham Junction in 1930, awaiting demolition

All photos by] [*O. J. Morris*

coach was placed in a chamber to which access could be obtained only when the collector bow was not in contact with the overhead wires ; this was dependent on a system of interlocking. To prevent any of the coaches becoming electrically charged through leakage from the bows, all the bodies were covered on their sides, as well as the roofs, with aluminium sheet which was bonded to the underframes and thus provided an earthed circuit throughout the vehicle.

Rolling-stock for the Crystal Palace extension was standardised at 54 ft. by 8 ft. on account of tunnel clearance restrictions. The three-coach units comprised first and third-class composite driving trailers each end, with a 600 h.p. third-class motor coach between. Each trailer had three first and five third-class compartments, and weighed 26¼ tons, while the motor coaches, which were equipped with four 150 h.p. motors, had a tare of 51¼ tons. Originally the motor coaches were placed at the ends of the units in these trains, but this caused an irregular location of the luggage compartments when arriving at station platforms, especially as the trains worked over a triangular route, which had a " turntable " effect, and the central motor coach location was then adopted. One or two (occasionally three) units coupled met all traffic requirements and no modifications were necessary as in the case of the South London units.

Although the extension to Coulsdon and Sutton was not opened until 1925, more than two years after the grouping, the rolling-stock was essentially of Brighton design. A single unit consisted of five vehicles, of which four were trailer coaches, and a fifth a 1,000 h.p. motor-brake placed in the centre. Contrary to previous practice, the motor-brake had a guard's and luggage compartment, but no passenger accommodation. This vehicle measured 38 ft. 6 in. over headstocks, and was 8 ft. wide ; its weight of 62 tons was equal to that of a five-coach train of steam-hauled six-wheelers. These motor vans had a driver's control cab at each end, and possibly the original intention was to couple them at the head of trains of non-electric stock ; as it was, they were always marshalled in the centre of the train and their driver's cabs were not normally occupied. When the Brighton A.C. electrification was abandoned, these motor-brakes became redundant, and for a while were stored in the up sidings at Streatham Hill ; later they were converted into bogie brake vans for freight trains. These, 21 in number, became the prototypes of a further batch of 25, though the latter were of new construction, and were provided with standard coach bogies.

As regards the livery of the " Elevated Electric " coaches, only those of the South London line appeared in the cream-and-umber colours that were introduced by R. J. Billinton, the Brighton Locomotive, Carriage and Wagon Superintendent from 1890 to 1904. Before the opening of the Crystal Palace extension, it had been decided to adopt an all-over umber brown livery, which persisted until the final closing of these services in the autumn of 1929. The 62-ton motor vans, however, were painted S.R. green.

All the trains carried route-indicating headcodes. Those of the South London line displayed a semi-oval white plate over the near side buffer, similar to that carried by steam locomotives over the same route. Ultimately, a square black board with the initials " S.L." in white was exhibited between the motorman's look-out windows. Crystal Palace line trains used a numerical headcode, which was an innovation on the L.B. & S.C.R., and were the first to display a square board indication. The figures 1 to 6 inclusive met the requirements of the lines in the Crystal Palace group, and a similar method of indication was used for trains over the Coulsdon and Sutton group of lines, to

which the figures 7 to 12 were allocated. No. 1 indicated Crystal Palace-Victoria *via* Streatham Hill ; No. 2 Streatham Hill-Victoria direct and also Crystal Palace-Streatham Hill ; No. 3 Norwood Junction-Victoria *via* Crystal Palace ; No. 4 Crystal Palace-London Bridge *via* Tulse Hill ; No. 5 London Bridge-Victoria *via* Tulse Hill Spur ; and No. 6 Norwood Junction-London Bridge. In the second group were No. 7 Selhurst-Victoria *via* Streatham Common ; No. 8 West Croydon-Victoria *via* Crystal Palace ; No. 9 Sutton-Victoria *via* Streatham Common ; No. 10 East Croydon-Victoria *via* Crystal Palace ; No. 11 Coulsdon North-Victoria *via* Streatham Common ; and No. 12 Coulsdon North-Victoria *via* Crystal Palace. Special trains carried, in addition to the ordinary headcode, a white disc with black centre by day and a purple light at night, the latter being reminiscent of a short-lived practice in 1900 for distinguishing steam trains running by way of the newly-opened Quarry line between Coulsdon and Earlswood.

For the maintenance and inspection of the overhead wires, two petrol-electric cars were used, on the roofs of which working platforms were fitted. These cars were introduced on the L.B. & S.C.R. in 1906 as passenger rail-motors and began their duties in the Brighton and Eastbourne areas. There was also a short four-wheel Drewry petrol car with overhead " tower " staging for conductor maintenance. All three cars were shedded at Peckham Rye shops. The whole 6,600-volt A.C. system, including the 1925 extensions, covered 37½ route miles, and was operated with 16 motor coaches and eight original trailers on the South London line, and 24 motorcoaches and 50 trailers on the Crystal Palace lines, while 21 1,000 h.p. motor vans and 80 trailers were available for the Coulsdon and Sutton lines.

The electric services took considerably less in overall running time between the terminal points than the steam trains they displaced, but they had the usual advantage of not being required to attach or detach loose vehicles at intermediate stations, and with few exceptions station stops were cut to 20 seconds apiece.

Few reminders of the overhead equipment remain to-day, except for specimens of the girders and supporting structures which may be seen in Norwood Yard, and at Peckham Rye, Pouparts Junction (cantilever type), Tulse Hill, and elsewhere. In some instances they are serving as signal gantries, and two specimens have been worked into the roof structure of Ryde locomotive shed in the Isle of Wight. The rolling-stock has been absorbed into the Southern Railway third-rail D.C. equipment, where it is now in constant use on a variety of routes.

The original 1909 motor coaches of the South London line are still at work on that route, after being adapted and formed into two-car units, one vehicle of which is now a trailer. The original first-class trailers, after the period of steam service, have reverted to electrical working, this time, however, on the West Croydon and Wimbledon line. They are run as two-car units, one vehicle continuing to perform its original function as a trailer, while the other has been motorised. With the exception of the motor coaches for the Coulsdon and Sutton line, the remaining rolling-stock, which is of the normal 8 ft. width, in some instances has been lengthened and formed into standard three-car suburban units. The remainder run as loose-coupled trailers, and are used for strengthening two-unit trains in peak periods, in which they are marshalled in the centre. Until they are replaced by the modern all-steel stock, the former " Elevated Electric " coaches are likely to continue to give as useful service to the Southern Railway as they did to the one-time London, Brighton & South Coast Railway.

ENGINES I HAVE DRIVEN

By Lawrence A. Earl (late Top Link, Camden Shed, L.M.S.R.)

YES, I am bound to say that I love speed. In my life I have had plenty of opportunity of travelling fast, too, for over thirty years of it have been spent on the footplate. As a youngster I had the ambition to become an engine driver, but I am such a little chap that I wondered if I should manage it. However, I decided to take my chance, and in 1901 I joined the old London & North Western at Camden shed as a cleaner. Fifteen years later, although there was only 5 feet 2 inches of me in height, I had got the regulator in my own hand for the first time. So my thirty years of driving began. It has been healthy work and a happy life, and I wouldn't have missed any of it.

When I look at a Pacific to-day—over a hundred tons of her and a fifty-ton tender behind that—it is odd to think of some of the engines on which I was just in time to do my first firing. Those Webb compounds like the "Teutonics," for example, with their four driving wheels and no coupling rods, so that sometimes you could catch the two pairs of drivers going round in opposite directions ! Or the little "Problem" class single-wheelers, with their driving wheels 7 feet 6 inches high, latterly as pilots to some of the bigger engines. And, of course, the famous "Jumbo" 2-4-0's ; I knew them all in my first shed days. But there was plenty of firing on shunting and goods engines before I got on to passenger turns. It is on goods trains that one begins to gain a knowledge of the road. Goods working takes one over all lines, fast lines, slow lines, loops and so on ; one learns to watch out for distant signals, and to sight the signals at all angles. One gets familiar, too, with the sight and sound of landmarks that help in locating one's position, particularly after dark or in misty weather.

The first link that I went into as a fireman was called a "special link." After twelve hours rest, we had to be ready to book on at any time after being called by the call boy, to work a special train, or to replace a driver or fireman who might be ill or having time off. Then came regular goods running. We had the old "18-inch goods" and "DX" 0-6-0's, or "Cauliflowers," as they were called, and used to run from London to such places as Rugby, Warwick, Bushbury, near Wolverhampton, and even as far afield as Manchester and Liverpool. It was mostly night work, six days a week and very often twelve hours a day, and all for a pay packet of forty-five shillings a week. But we were happy enough ; those were the "good old days," make no mistake about it.

Well, in course of time—1916 it was—I started driving, and after the usual start on shunting and goods and slow passenger work I got into the Birmingham passenger link at Camden. The days of the London & North Western as an independent company were nearly at an end. Our passenger engines on this job were mostly the "George the Fifth" 4-4-0's and the superheated "Precursors," and grand engines they were. With the fast timing of these trains, after we had recovered from the First World War, we could go along at any old speed, and that just suited me. Once I took a No. 1387, *Lang Meg*, on the 11.30 a.m. from Euston to Wolverhampton, first stop Coventry. Foreman Fitter Gerard told me I had better go easy with the engine, for she was just due for the shops. "Righto," I replied. Well, we had nine on, 289 tons, yet somehow we got

through Rugby, 82½ miles, in 75 minutes, and after we had had a bad slowing past Banbury Lane box, where they were renewing the locking. The following week *Lang Meg* did make her way down to Crewe Works. I hope I hadn't hurried her there !

On another trip with the 11.30 we strolled into Coventry exactly at 1 o'clock, 7 minutes early—the train was allowed 97 minutes for the 94 miles from Euston at that time—after I had been enjoying myself thoroughly with something not far short of 90 miles an hour at Sear's Crossing. At Coventry I saw the restaurant car conductor walking up to the engine. " You've done it now," he said. " Done what ? " I asked. Well, it appeared that they had a new pantry boy on the cars, and he had stacked all the cups and saucers and plates and teapots and whatnot up to dry after they had been washed, in an unsafe place. A bit of speed and a bit of a curve at Heyford had done the rest ; and the boy had spent most of the time from there to Coventry picking up the bits off the floor, and expecting to be sacked straightaway. However, they comforted him, and told him that he would get used to me in time.

The same day I gave my mother a taste of speed coming back on the 4.15 p.m from Wolverhampton, and made her ride in the front coach to feel it properly ! By this time, I should have said, the old North Western had become part of the London, Midland & Scottish Railway, and the " Crimson Ramblers "—the Midland compounds—had come to Camden to replace the " Georges." There was nothing wrong with the compounds. When you had mastered the tricky Deeley regulator, with its small opening letting boiler steam straight down to the low pressure cylinders, all was plain sailing. I never followed the Midland plan of letting the train get well into speed before changing over from simple to compound working ; to my mind the boiler and the fire took too long to recover if one did that. In my judgment the engines did much better if one changed over to full compound directly the train was nicely on the move. That night we did the 77½ miles from Rugby to Willesden in a little over the hour, and touched 90 on the way up. I have seen all sorts of calculations to prove that the compounds couldn't do 90 miles an hour ; that may be all right in theory, but in practice, if they were handled properly, they just did it ! To my mind they were quite the freest-running engines we had at Camden at that time.

Every now and again I would get a " Prince of Wales " 4-6-0, especially after getting moved into the Shrewsbury and Manchester link. The Shrewsbury turn was on the 5.10 p.m. " semi-fast " out of Euston, and we used to have a light five-coach train of about 145 tons. The " Princes " had a lively turn of speed, and twice over, after the down " Merseyside Express " had passed Wolverton on the fast road just as we were starting on the down slow, I have overhauled her just as she was passing Roade, 7½ miles away. Once one of the famous Coats' cotton people missed the last train to Scotland and chartered a special, which I had to work with a " Prince " as far as Crewe. Unfortunately we had only two coaches on, so I had to go steady for want of brake-power ; however, we got the gentleman to Crewe in 155 minutes for the 158 miles.

I used to love the Manchester runs. Some of the trains, like the 8.30 a.m. from London Road to Euston, were light and easy to work, and we had " Baby Scot " 4-6-0's, as the " Patriots " were called in their earlier days. They were in first-class condition, and grand engines, very light on coal. At times my fireman Lapham and I would experiment to see on how little coal we could bring the 8.30 up to London. Once, with a six-coach train of 189 tons, I made up the fire myself ; six times only was enough for the

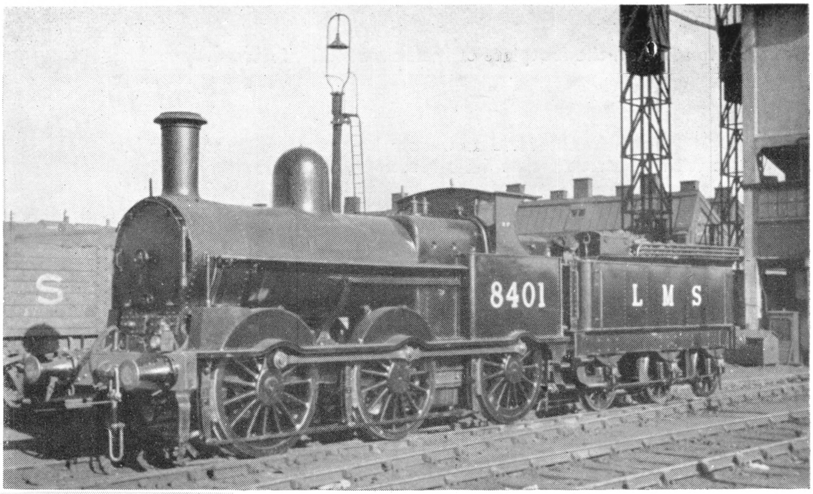
"ENGINES I HAVE DRIVEN"

Right : Driver Earl on the footplate of Pacific No. 6224, *Princess Alexandra*
[*Daily Herald*]

Centre : Driver Earl lifts the 11.15 a.m. from Liverpool to Euston out of Lime Street with "Patriot" class 4-6-0 No. 5527, *Southport*
[*Canon E. Treacy*]

Below : A superheated "Precursor" 4-4-0, No. 5310, *Thunderer*, climbing Camden bank with a seven-coach Manchester express
[*F. R. Hebron*]

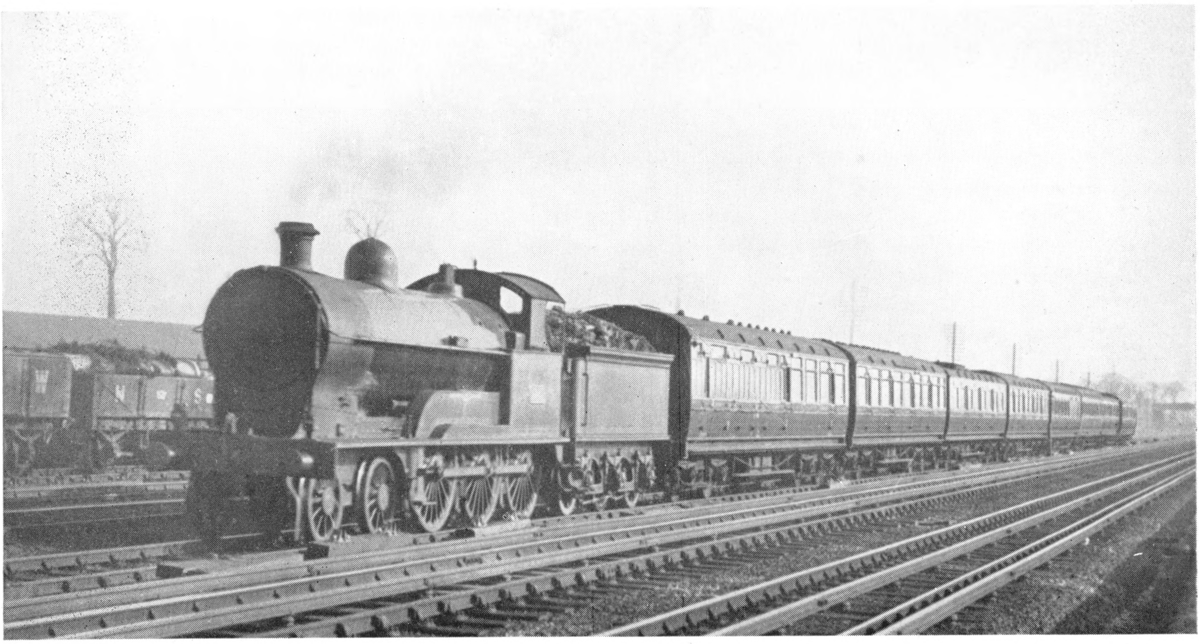
SOME VETERANS OF THE L. & N.W.R.



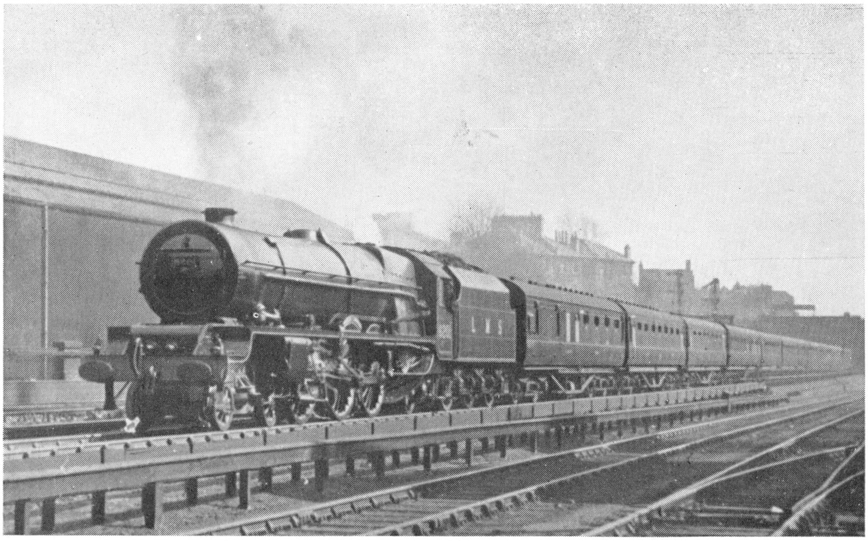
Above : One of the 5 ft. Webb 0-6-0's (L.N.W.R. No. 2313) with wooden buffer-beam and tender frame [*H. N. James*]

Left : "Jumbo" 2-4-0 *Penrith Beacon* (L.M.S.R. No. 5069) hard at work near Hest Bank, North Lancashire [*F. R. Hebron*]

Below :
"Prince of Wales" 4-6-0 No. 1321, *William Cowper*, heads a Manchester tea car express past Kenton [*F. R. Hebron*]



MODERN L.M.S.R. LOCOMOTIVES



Left : ON CAMDEN BANK
Pacific No. 6201, *Princess Elizabeth*, sets out from Euston to Liverpool with a heavy down express [*C. C. B. Herbert*]

Below : MAJESTY IN ACTION
Pacific No. 6230, *Duchess of Buccleuch*, forging her way up the 1 in 75 of Shap with the 10 a.m. from Euston to Glasgow [*M. W. Earley*]

MODERN L.M.S.R. LOCOMOTIVES

Above :

A rebuilt " Royal Scot " 4-6-0 on the long climb from Settle Junction to Blea Moor, Midland Division—a striking view of No. 6117, *Welsh Guardsman*, taken from the footplate by Canon E. Treacy

Below :

A " Royal Scot " in its original condition, with smoke-deflectors added ; No. 6157, *The Royal Artilleryman*, (now also rebuilt) passing Wavertree with a Liverpool-Euston express [*Canon E. Treacy*]

entire run, with plenty put in at a time, of course, but spread carefully over the grate. The last firing was at Blisworth, after which the fire was not touched again for 63 miles up to London. Talking of coal experiments, once we brought a goods from Walsall right through to Camden yard, with a " Prince of Wales," and fired her four times only ; another time, when George Jack was firing for me on Pacific No. 6212, *Duchess of Kent*, with a 466-ton train on the 11.45 p.m. Glasgow sleeper, he never needed to touch the fire from just beyond Lichfield into Crewe, a distance of 40 miles. Given good coal, there are few modern engines that will not run economically, provided the firemen use their brains and take an interest in what they are doing.

I always thought the " Patriots " had a better turn of speed than the " Royal Scots," though I liked the " Scots " well enough. By now the trains were timed much faster, and that suited me down to the ground. With all the " on time " push on the L.M.S.R. in the middle 1930's, too, all the staff were on their toes—enginemen, signalmen, and even " control "—so we could be reasonably sure of " getting the road." One of the best runs I ever made with a " Scot " was one day on the 4.10 p.m. from Manchester to Euston, which was due away from Crewe at 5.3, 33 minutes ahead of the " Coronation Scot," and was timed to stop at both Stafford and Nuneaton, but still to get into Euston 13 minutes ahead of the streamliner. If you were late a few minutes with the Manchester, you knew exactly what to expect. At Roade you would be turned slow line, and would have to fiddle about down to Wolverton to let the blue train get by before you could get back on to the fast line ; and I used to show a clean pair of heels to avoid that at all costs. This particular day there had been delays between Manchester and Crewe, and we left Crewe 10 minutes late. Fortunately I had a good engine—No. 6125, *3rd Carabinier*—and a first-class fireman, Tom Russell ; the load was all right, too, 11 on, 356 tons, 59 tons more than the " Coronation Scot " trying to catch me up. Well, she didn't !

On the train that day we had Mr. R. E. Charlewood, a well-known train timer, and he made a very careful record. All the way we were picking up time, but the liveliest running was after we had passed Rugby, for we ran the 72¼ miles from Welton to Kilburn at an average of 76.6 miles an hour the whole way. The highest speed was 85 miles an hour through Wolverton ; the best bit of work, I think, was the time of 2 seconds over 12 minutes for the 15 miles of uphill from Bletchley to Tring. So we made the run of 97 miles from Nuneaton to the dead stand in Euston in 86 minutes, 47 seconds, and by regaining 11 minutes in all from Crewe we were into the terminus a minute ahead of time. Mr. Charlewood calculated that if mine had been a non-stop express from Crewe, my " Royal Scot," on the running I had made, would have done the 158 miles in 141½ minutes, or 2½ minutes less than the big Pacific with the lighter streamline train.

It will be noticed that we did not touch 90 miles an hour on this run. Despite what a young driver wrote recently about going through Harrow with a " Royal Scot " at 95 miles an hour on his very first passenger trip, I take leave to doubt it. Not so the " Baby Scots " ; you could get any speed you liked out of them. One day on the up "Mancunian," non-stop for 177 miles from Wilmslow through to Euston, with No. 5525, *Colwyn Bay*, the left-hand injector was giving trouble, and I had to stop specially at Polesworth to put it right. But I wasn't going to be late, so we ran the 106½ miles from there up to London in 92 minutes, and with 366 tons of train.

About this time I was getting some of the Liverpool turns, and especially the 5.25 p.m. up, a grand train for speed. From Crewe up to Euston we had only 148 minutes for the

158 miles, so we simply had to step it out. Now I was getting the Pacifics to work, too, and they are lovely engines. One night, when I had No. 6209, *Princess Beatrice*, and a 300-ton train, it was going to be my last Liverpool trip for some time, and I wanted to celebrate the occasion. So I husbanded the steam in the boiler until we could let fly up the rise from Bletchley to Tring. My mate Tuffery thought his watch had stopped when we passed Tring, because it showed something like 9 minutes from Bletchley. When we got to Euston, our guard, Robinson, a big six footer, came up to the engine. " Hullo, Robbie," I said. " How are you feeling ? And what did you make the time from Bletchley to Tring ? " Looking at me in a very old-fashioned way, he said, " Why, nine minutes, and I don't want any more of it either. I had to take my teeth out, you were shaking us up so much." Probably nine minutes was a bit on the tight side, but we certainly didn't take more than ten, and even that is 90 miles an hour for the whole of 15 uphill miles.

We used to get the " Turbo " on this trip, and what a lovely engine she is ! Not so much science about the driving, perhaps—turning the valves on and off one by one instead of the careful adjusting of regulator and cut-off to suit every change of the road—but for continuous strength and speed there is not another engine in her class to touch her. Once in the late 1930's the " Turbo " was tried for a week between Euston and Glasgow on the " Royal Scot," and Fireman D. Wright and I were the crew chosen to man her to and from Carlisle. There can't have been much wrong with his firing, because one day we climbed the 31½ miles from Carlisle up to the top of Shap Summit, 915 feet above the sea, in no more than 36 minutes, and with a train of 530 tons behind us.

In all my driving life, I think I enjoyed the Carlisle run more than any other turn. It was fine to see so much of the country on a single trip—busy London to start with, the green fields and hills of the Midlands, and then through the black coal country round Wigan until we skirted the sea along Morecambe Bay and saw the mountains ahead into the heart of which we had to climb. We had to drive and fire carefully going north, so as to have plenty of steam left with which to get our heavy trains up Shap, right at the end of the run. It was good to know, too, that with non-stop trains, like the " Royal Scot," we were making the longest regular non-stop run—Euston-Carlisle, 299 miles—in the world. Once in 1941, after the war had begun, I had the privilege of working King George VI and Queen Elizabeth from London to Carlisle with No. 6227, *Duchess of Devonshire*. It was the first time the Royal train had ever made this journey without stopping at Crewe for examination.

One run on the " Royal Scot " train that I well remember was on a day when Mr. Cecil J. Allen was on board, and I wanted to show him what we could do with one of the original " Princesses." Personally I have always thought we were better off with the 6 feet 6 inch drivers of these engines than with the 6 feet 9 inches of the later engines. This was No. 6206, *Princess Marie Louise*, and we had 16 on, 492 tons all told. It was after we had been held up by a bad permanent way slowing at Berkhamsted that I was able to get going. From Tring to Hillmorton, just outside Rugby, we averaged 77.2 miles an hour for very little short of 50 miles. Even up to Kilsby tunnel we went at 70 an hour and we were twice up to 85 an hour with this big train. Later in the same trip we got our 492 tons up from Tebay to Shap Summit in 3 seconds under 8 minutes—not bad going for just over 5½ miles and most of it a 1 in 75 uphill grind. My fireman on this trip was G. Abey, and we were never short of steam anywhere.

Of course we had all kinds of other engines to work from time to time. There were

the "Jubilees," for example, which we used to get on the "Blackpool and Fylde Coast Express" run. One day we were coming up with No. 5552, *Silver Jubilee*, herself, when between Wigan and Warrington our second injector started to go wrong; already the first wasn't behaving itself properly. I had to stop at Hartford to get one of them going temporarily, and wired to Crewe for another engine. This turned out to be No. 5049, a black Class "5" six-footer. As we were late, the up "Mancunian" was due through Crewe any minute, but I asked Major Cowley, the stationmaster, to let us get away first, and he did. I expect he knew what I should get up to; and anyway we had on the train Mr. Ashton Davies, one of the Vice-Presidents, who wanted to be in London "on time."

The timing of the train was not one which allowed us to hang around—154 minutes for the 158 miles to Euston—but, to cut a long story short, we pulled out of Crewe 13 minutes late and rolled into Euston 2 minutes ahead of time—158 miles in 139 minutes. When we were travelling very fast, my fireman started to look over the side of the cab at the coupling rods whizzing round, but I told him to keep his eyes through the cab window ahead if he didn't want to get nervous. When we stopped, a lady and gentleman came up to the engine with a boy of 14 or so, and he stuck his hands in his pockets and said to me with a grin, "Why don't you get a move on, driver?" Cheeky youngster!

When the Second World War came on, it was just like going to sleep—no more fast trains, no more speed, indeed, nothing more than a mile-a-minute for a time, though they did ease that out to 75 miles an hour later. And as the years went on, by the end of the war and after, even when the engines have been in good condition and the coal something better than dust, how seldom we could get the road! Occasionally we did, though, like the night when I was working the 5.25 from Liverpool, and came into Euston 24 minutes ahead of time, at 9.5 instead of 9.29. Some time after we had stopped, a press photographer came strolling along the platform and said he was there to take the picture of two prisoners who were coming from Liverpool up to London to be tried. Where would he find the Liverpool train? "Why, chum," I said, "this is it. Don't leave it so late another time. You'd better go to prison after them now!"

Once I was booked to run a special train down to Coventry that had been chartered by the Hillman motor people, and among the passengers there were four well-known racing motorists—Sir Malcolm Campbell, Major Seagrave, Mr. Kaye Don and Mr. Birkin. They enjoyed the speed so much that between them they made quite a handsome present to the engine crew. Later on I made the acquaintance of another racing motorist, Mr. M. Couper, and he took me round Brooklands track in his Talbot—we did a lap at 112 miles an hour and touched 125; it was grand. They took me to lunch at Brooklands Flying Club, and asked me if I would like to go up as well, and of course the answer was "Yes." So that day I had my first 'plane trip and looped the loop into the bargain. All I need now is to go down in a submarine—and what about a flying trip in a "Meteor"? Well, some day, perhaps.

I always wanted a chance to do something really speedy on the L.M.S., but I never achieved this ambition. If the L.N.E.R. could do 126 miles an hour with their *Mallard*, I am perfectly certain I could have done 130 with one of our "Duchesses" on a similar piece of road. And how I have wished we could have had another of those locomotive exchanges, like the time when *Launceston Castle* of the G.W.R. came running up and down to Carlisle in 1926! My word, it would be a very different story nowadays—but someone else than myself will have to tell it!

THE CHURCHWARD INFLUENCE

Recollections of a Great Locomotive Engineer

By " North Star "

NO other single locomotive engineer, it is safe to say, has exercised so profound an influence on British locomotive design in general as did the late George Jackson Churchward of the Great Western Railway. So far as the G.W.R. itself is concerned, the principles of design laid down by Churchward have continued largely unchanged under his two successors for a quarter of a century since his retirement in 1921—a tribute to his work that is all the more striking when one remembers the drastic changes which have followed the disappearance from office of not a few other locomotive engineers with strongly marked individuality. As regards other railways, Churchward's greatest triumphs did not come until after he had relinquished the reins of office at Swindon, though fortunately he lived long enough to see the full results of his work. Could he come to life again to-day, he would find many of his engines running almost exactly as he built them, and far less of change than any of his contemporary locomotive engineers.

The continuity of Great Western policy in general has been helped by the fact that promotions to the company's highest offices have always been made from inside the G.W.R. service. This has been the case in the Locomotive Department, and, in addition, the tenure of office of its chiefs has been unusually lengthy. William Dean, Churchward's immediate predecessor, reigned at Swindon for 25 years, from 1877 to 1902 ; then came Churchward, who from 1896 had been Dean's Locomotive Works Manager, and now became Locomotive, Carriage and Wagon Superintendent—a title altered in 1916 to Chief Mechanical Engineer. Churchward continued for 19 years, until 1921, to be followed, in his turn, by Charles B. Collett for a further 20 years, and then, in 1941, by the present holder of the office, Mr. F. W. Hawksworth.

The first of the revolutionary changes in Great Western practice generally associated with Churchward's name actually had begun during his term as Locomotive Works Manager ; to what extent he influenced his predecessor Dean, or *vice versa*, it is not easy to say at this remote date, though it seems fairly certain that of the two Churchward was the driving force. Early in 1899 there emerged from Swindon Works a new 4-4-0 named *Waterford*, and numbered 3310. The pitch of the boiler was higher than before, so much so that, according to the April, 1899, issue of the *Locomotive Magazine*, " the dome has had to be dispensed with, and the safety-valves, which are a modification of the Ramsbottom type, are placed on the barrel instead of on the top of the firebox as usual."

Actually the G.W.R. was in course of introducing what ever since then has been standard practice—a domeless boiler, with the collection of the steam through a perforated pipe in the high front corner of the firebox. As compared with the enormous dome

MODERN G.W.R. MOTIVE POWER

Right : No. 4933 *Himley Hall* piloting No. 4073 *Caerphilly Castle* up the steep ascent from the west to Dainton Tunnel
[*B. A. Butt*]

Left : With special timekeeping numbers on the smoke box. No. 6011, *King James I* is seen climbing past Gerrard's Cross with the heavy 6.10 p.m. Birkenhead "diner" from Paddington [*C. R. L. Coles*]

Right : No. 5036, *Lyonshall Castle*, works a down Plymouth Express away from Reading past Southcote Junction. This engine also carries the train identification numbers
[*M. W. Earley*]

HEAVY G.W.R. ENGINEERING WORK ON THE RUISLIP TUBE EXTENSION

THE FLY-OVER BRIDGE CARRYING THE ELECTRIC LINES OVER THE GREENFORD-EALING BRANCH
The two " N " type steel girder spans are approached by lengthy concrete approach viaducts

A 60-FT. SPAN ELLIPTICAL ARCH ACROSS GREENFORD ROAD
The arch is built of seven rings of solid brickwork, 3 feet thick ; the abutments are of mass concrete

covers which had been customary on G.W.R. engines up to that time, the change in appearance brought about by this development was striking indeed. *Waterford* was the pioneer of a string of new 4-4-0 types ; later in 1899 came *Camel*, the first to be fitted with a circular saddle-supported smokebox ; then *Atbara*, in 1900, the first to be designed with the high square-cornered raised platform over the coupled wheels ; and finally, in 1903, the famous all-Churchward "Cities," which incorporated this designer's principles in full, and soon showed by their performance the thoroughgoing effectiveness of his methods.

Then, within a month or two of Dean's retirement, Swindon Works turned out its most notable production to that date—the first G.W.R. express passenger 4-6-0, No. 100, given the name *Dean*, which was amplified later to *William Dean*. It would be interesting indeed to know how much of this design was Dean's, and how much Churchward's, though, as has been remarked already, the inference here is fairly obvious. For the first time in G.W.R. practice there was incorporated the long 30-inch stroke, which since has been standard with so many Great Western two-cylinder classes, though on no other British railway. The boiler barrel was of the parallel type, as Churchward's first taper boiler was not seen until the following year. At the same time, the outside bearings to all wheels, which had been a feature of many Great Western tender designs until then, including all the new 4-4-0 classes and the two previous 4-6-0's (No. 36 of 1898 and No. 2601 of 1900, both intended for goods service and the latter the precursor of the "Aberdare" 2-6-0's), were abandoned, and the running plate was lifted to a considerable height, from the cylinders back to the cab, the latter being so far above the ground as to need a series of three steps to climb up into it.

Thus, in 1902, there began the long series of Great Western 4-6-0 locomotive designs. At first Churchward seemed a little uncertain as to whether G.W.R. needs would best be met by the 4-6-0 or the 4-4-2 wheel arrangement, for the development of the latter on the Great Northern Railway was attracting a good deal of attention. So also were the de Glehn four-cylinder compound Atlantics of the Northern Railway of France, which were doing such magnificent work that in 1903, a year after Churchward came into office, an engine of the latter type was obtained from a well-known firm of locomotive builders in Belfort, France, for direct trial on Great Western metals. This was No. 102, *La France*.

On the arrival of No. 102, there were two G.W.R. 4-6-0's at work, Nos. 100 and 98 ; No. 98 had the taper boiler which Churchward standardised from that time on. In 1904 No. 171 appeared, making a third 4-6-0 ; but in the same year this engine was taken back to Swindon, and converted to the Atlantic wheel arrangement, that a more direct comparison might be obtained between the performance of the French and the British engine. For the same reason, the latter was fitted with a boiler pressed to 225 lb. per sq. in., a record at that time for a British-built locomotive, because the French locomotive carried a pressure of 227 lb. Yet another feature of Churchward practice—high working pressures—was established in this way, at a time when the general figure in new British designs was more generally 180 lb. or less.

Once having begun the building of Atlantics at Swindon, Churchward went on until in a comparatively short time there were 14 of these engines, Nos. 171, 172, and 179 to 190 inclusive, all named after characters in the Waverley novels of Sir Walter Scott. The fifteenth and last was a four-cylinder Atlantic, No. 40, *North Star*, built in 1906 to make possible a comparison between a British four-cylinder simple Atlantic and the two

larger French compound Atlantics, Nos. 103, *President*, and 104, *Alliance*, which followed No. 102 from France on to the G.W.R. in 1905. But although the French compounds did some notable work in the hands of their British crews, the methods of valve-setting adopted by Churchward in his simple designs—his principal claim to fame in the realm of locomotive engineering—produced such efficient results that the compounds, with their more expensive construction, showed no measurable superiority.

Also, as through locomotive workings had now come into force between Paddington and Plymouth, the limited adhesion of the 4-4-2 wheel arrangement was badly against the Atlantics in negotiating the formidable banks of South Devon, such as Hemerdon, with its two miles at 1 in 42. This affected the Churchward Atlantics equally, and by the middle of 1907, No. 171, *The Pirate*, had been reconverted to a 4-6-0 and renamed *Albion*. So *Albion* had the unique experience of running as a 4-6-0, 4-4-2, and again as a 4-6-0, all in the brief space of a little over three years. No. 40, *North Star*, followed suit in 1909, was later renumbered 4000, and later still was rebuilt as a " Castle," which is her present form. No time was then lost in converting all the remaining Atlantics to 4-6-0's. By now, therefore, Churchward had a considerable number of the " Saint " two-cylinder 4-6-0's at work, and the first of the four-cylinder " Stars."

The secret of the Churchward technique was simple enough, and it is astonishing that a quarter of a century was to elapse before his commanding lead was followed elsewhere. It traces back to the piston-valves first introduced during the Dean *régime*, with their reduction in frictional loss as compared with the flat slide-valves then in general use. Piston-valves in their turn permitted longer valve-travels without fear of undue valve wear ; and with longer valve-travels it became possible to cut off earlier in the piston stroke without excessive compression in the cylinders at the end of the stroke.

These longer valve-travels, again, made it possible for drivers to combine a full opening of the regulator, without throttling as the steam entered the main steam-pipe, with cut-offs brought back to, say, 15 per cent in normal running conditions. Added to all these, Churchward was the earliest British advocate of high working pressures ; the French compounds, as already mentioned, were the spur to his adoption of 225 lb. per sq. in. as the pressure for his principal locomotive classes. Part of the Churchward " front-end " design was the provision of exceptionally large steam and exhaust ports, extending right round the cylinder, which help to explain the explosive sound of the exhaust of practically all Great Western locomotives.

In the design of boilers and of the " front end " generally, Churchward was an expert, though there are reasons for thinking that his work on chassis design was not of quite the same outstanding merit. Some proof of this contention is found in the difficulties that were experienced with his Pacific of 1908—the first standard gauge express locomotive of this wheel arrangement in Great Britain, leading the Gresley Pacific design by no less than 14 years. The trouble with No. 111, *The Great Bear*, was the inflexibility of the wheelbase, which tended to make the engine leave the track on curves, especially cross-over roads, and eventually resulted in the conversion by Collett of the 4-6-2 to a " Castle " class 4-6-0, *Viscount Churchill*.

As with many of the greatest locomotive designers, Churchward had certain prejudices, and not a few of these persist in Great Western locomotive designs to the present day. One is the objection to high temperature superheat. On the G.W.R., superheaters are of such limited capacity that what goes on in them is more strictly steam drying

rather than full superheat. The underlying idea is that the steam shall not be superheated to such a degree that any of the superheat is thrown out of the chimney with the exhaust, and thereby wasted. When Sir William Stanier tried to take the same principle from Swindon to the L.M.S.R., on his appointment as Chief Mechanical Engineer of the latter company, he soon found that it would not work, and the Class "5XP" 4-6-0's and various other Stanier engines in a very short time had to have larger superheaters fitted, in order to overcome trouble with poor steaming.

No doubt the principal difference between G.W.R. and L.M.S.R. conditions was in the quality of the coal normally used on the two systems; later, Sir William became a convert to high temperature superheat to such an extent that his second series of Pacifics have the largest superheater of any British locomotive type. It was not until the current decline in the quality of coal had set in, as a result of the war, that the G.W.R., in its "11M" standard boiler, as fitted to the "Halls" from No. 6959 onwards, and the latest "Castles" from No. 5098, tried the effect of increased superheating surface.

No other British railway shares the Great Western fondness for the domeless boiler, and on no other line is the Ramsbottom type of safety-valve adhered to in preference to the more modern "pop" valve. Another G.W.R. prejudice is against the use of the outside Walschaerts valve-motion so universally popular elsewhere. The "Castles" and the "Kings" certainly have Walschaerts motion, but in a somewhat inaccessible inside position which does not simplify maintenance. On the other hand, even so recent a design as the "County" 4-6-0 still has the Stephenson link motion. As to minor details, the Great Western is also alone in sticking to gravity sanding in preference to steam sanding. All these features were standardised during Churchward's tenure of office.

Nevertheless no observer who has been privileged, as I have, to ride on Great Western engines can fail to be impressed by the working out of the Churchward principles in the way in which the locomotives are handled. I have never travelled on any other engines which are responsive to such precision of working as changes in cut-off of no more than 1 or 2 per cent at a time. My experience, I admit, has been with the Collett "Castles" and "Kings" and the new Hawksworth "Counties," but except with the last-mentioned, which normally run with a rather longer cut-off and the main valve of the regulator partly open only, the Churchward principles of working remain unchanged. Another impressive feature of G.W.R. locomotive working is the almost complete freedom of the engines from slipping. This is the more remarkable in view of the high tractive effort of the "Castles" and the "Kings"; the "King" 40,300 lb. exceeds the tractive effort of most British Pacifics, with their pronounced tendency to slip on starting.

Many standard Great Western classes were born during the Churchward *regime*. In the year 1903 came the "City" 4-4-0's, which achieved various notable records, including that of *City of Truro*, in attaining 102½ m.p.h. in the descent of Wellington bank with a mail special on May 9th, 1904. The first 2-8-0 freight locomotive appeared in 1903, and also the first 2-6-2 tank. The year 1904 saw the emergence of the original Churchward "Counties," a series of outside-cylinder 4-4-0 engines, and in the following year came the "County" tanks, of the 4-4-2 type with outside cylinders. To *The Great Bear*, a 4-6-2 product of 1908, reference has been made already. Next, in 1910, the first of the heavy 2-8-0 mineral tanks were turned out, intended chiefly for the heavy gradients of the Welsh valleys.

Up to 1911, the only Moguls had been those of the inside-cylinder outside-bearing

" Aberdare " class, designed in Dean's time, but 1911 saw the emergence of the first of the numerous Churchward outside-cylinder Moguls, which were to do all the fast freight work until the " Halls " were begun in 1928. Churchward's final design was the " 4700 " class 2-8-0, with 5 ft. 8 in. driving wheels, for fast freight traffic, in 1919 ; nine only of these engines were built. Throughout this period, 4-6-0 express engines of both the " Saint " two-cylinder and " Star " four-cylinder types had been constructed in considerable numbers. By 1921, the year of Churchward's retirement from office, standardisation and interchangeability of parts had proceeded further on the Great Western, it is safe to say, than on any other British railway.

It was after Churchward's successor, Collett, had built the first of the " Castle " class 4-6-0's, in 1923, that Churchward was destined to see the most triumphant vindication of his principles of design ; for the " Castles " were a logical enlargement of the Churchward " Stars." This vindication occurred, of course, when the historic exchange of locomotives took place between the G.W.R. and L.N.E.R. in 1925. During the test weeks, both *Caldicot Castle*, on G.W.R. metals, and *Pendennis Castle*, on the L.N.E.R., did work equal, and, if anything, slightly superior to that of their Gresley Pacific rivals, and on a slightly smaller consumption of coal in each case. A similar exchange with the L.M.S.R. in 1926, when *Launceston Castle* made trial runs between Euston and Carlisle, had results even more emphatically in favour of the G.W.R. engine.

The upshot of the latter tests was the building of the L.M.S.R. " Royal Scot " 4-6-0's, and of the former the re-design of the motion of the Gresley Pacifics with longer valve-travels, followed shortly by the building of the " A3 " Pacifics with higher boiler pressures. Already Swindon front-end principles had spread to the Southern Railway, and at last it had become standard practice with all four main line railways to build locomotives with higher working pressures and valve-motions designed for short cut-off working.

Another indirect triumph for Churchward, the year before he died, was when one of his disciples, Mr. W. A. Stanier, steeped in Great Western traditions, was appointed as Chief Mechanical Engineer of the L.M.S.R. in 1932. The following year Churchward died. Through his twelve years of retirement his heart was still in the great works which had so largely been his own creation, and from his house across the other side of the main line it was his habit constantly to cross into the works to see what was going on. It was on one of these vists, owing to his deafness, that he failed to hear an approaching train, when crossing the line, and was knocked down and fatally injured—by one of his own engines. Perhaps he would have wished it so !

It is interesting to speculate as to whether Churchward, had he remained in office for a longer period, would have allowed the general principles of his designs to have remained so static as they have done at Swindon during the 26 years since his retirement, or to what extent he would have been influenced by later developments in the technique of locomotive design, as Sir William Stanier has been. Would the first British locomotive engineer to build a Pacific have gone back eventually to the 4-6-2 wheel arrangement ? Who can tell ?

THE END

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